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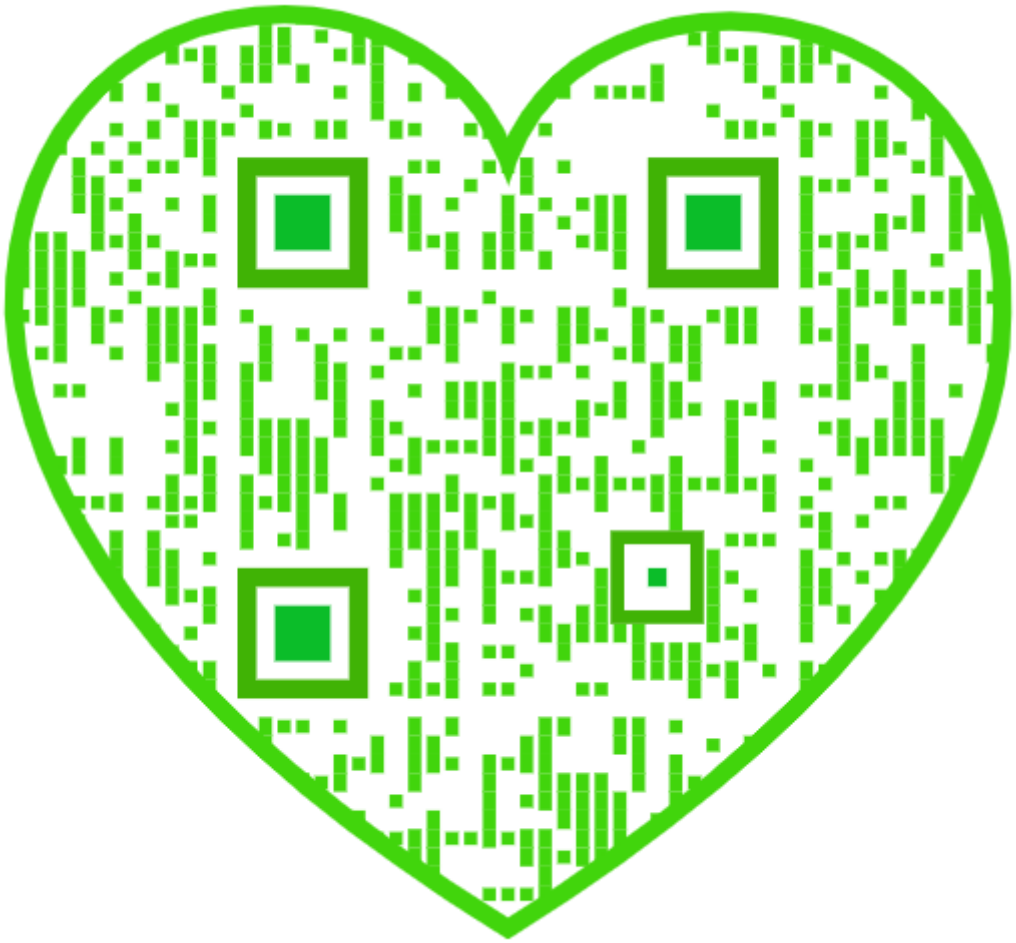

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EDITORIAL

FINANCING ROAD AND STREET PROJECTS

So important has the financing of roads and streets become that in the case of roads, at least, it is now receiving more study than any other factor in the problem. Design and construction are, for the present, overshadowed by finance.

When the American people finally made up their minds to build roads on a great scale they were not especially critical of the financial arrangements. Now this is changed. The people now feel the weight of the cost of modern roads and an individual is quick to oppose a project if he feels that he will be asked to bear more than his fair share of the burden. But he is willing to bear his share, so the problem is to work out equitable taxation for road and street purposes.

The old principle of assessment according to benefits is the one toward which road taxation is rapidly turning. A good road is of some service, directly or indirectly, to every person residing in the political subdivision in which it is located, so it is entirely fair to levy general taxes to pay in part for the cost of road construction. It is evident to all that the man who uses the road derives more benefit from it than the one who does not, and the vehicle license fee, which should be turned into the road fund, is the approved method of paying for this benefit. It is also evident that the vehicle license fee, while all right as far as it goes, does not go far enough in fairly exacting payment for benefits, for the man who drives a car 15,000 miles a year should pay more for the privilege of using the roads than the man who drives only 5,000 miles. The gasoline tax, now rapidly growing in favor throughout the entire country, is an attempt to charge road users in direct proportion to their use of the roads. It is also evident that the man living close to a road derives more benefit from it than the man who does not, and tax officers are giving thought to the formulation of equitable plans for taxing property holders in the areas adjacent to a new road. The man whose farm lies along a new hard-surfaced road finds that the construction of the road adds to the market value of his property. Surely he should pay something for this direct benefit in addition to his general road tax.

Perhaps the most significant development in financing street improvement projects is in the attempt again to tax according to benefits as shown in the increasing practice of paying for resurfacing and reconstruction out of general tax funds instead of assessing such costs against the abutting property. It is argued, and quite soundly so, that although the first paving of a street increases property values, resurfacing or repaving does not, so while it is equitable to assess the first cost against the abutting property, it is not fair to make the abutting property pay the subsequent costs arising from the destruction of the pavement by traffic originating at distant points.

The best thought of road and street engineers should now be turned to this problem of equitable financing.

THE GRAVEL ROAD

It is generally agreed that gravel roads do very well for secondary road construction, serving as feeders to hard-surfaced primary roads, but attempts to make the gravel road a primary road are to be deprecated. The primary road should be of such construction that it will carry rapidly and safely all forms of legitimate, modern traffic at any time of the day or night, in any season of the year, and in any kind of weather. A gravel road does not meet these requirements.

All this is equivalent to saying that a

gravel road is all right in its place, but attempts to make it serve as a substitute for higher types prove both disappointing and expensive. There is a general disposition to speak well of the gravel road because of its long service to the American public and because of its good qualities within its natural limitations, and very little would be said against it but for the fact that one occasionally hears comparisons drawn between gravel and higher types in favor of the gravel road. Such comparisons are usually made by motorists who use the roads but infrequently, and then only in dry weather, who fancy that gravel possesses superior riding qualities. It is noteworthy, however, that where the motorist has his choice between two roads, one of gravel and the other of a higher type, when he is actually on the road, he almost invariably chooses the hard-surfaced road even if it is the longer of the two. A good example of this fact is found in the trip between Indianapolis and Chicago. One route, the shorter by 30 miles, is almost entirely of good gravel construction under excellent maintenance, while the other is for something over half its length of hard-surfaced types. Fully 90 percent of the traffic between these two cities is over the longer route. Thus it is seen that in driving 225 miles motorists are willing to go 30 miles out of their way in order to secure the advantages in comfort and safety of driving on 130 miles of modern roads.

It is interesting to observe the effects of travel on this trip. Going one way, the driver and his companions are tired at the end of 95 miles, the end of the gravel road. After driving another 130 miles over hard roads all are pretty well rested again. On the return trip there is only moderate fatigue at the end of the 130 miles of hard roads, while after driving another 95 miles over gravel, children, especially, are thoroughly tired. Any one who takes this trip, or a similar one, will appreciate the fact that gravel is not suitable for primary road construction for passenger traffic from the standpoint of creature comfort, even if the dust is disregarded. There is a bodily weariness produced by the gravel road to which the traveler over a higher type is a stranger.

In the early spring and late fall, when the trip is attempted, all the anxiety as to the condition of the road centers in the gravel section. Not a thought need be given the hard-surfaced section, for it is always good. The gravel section may be rough and rutted, out of surface, bottomless and otherwise in poor shape, due to nothing else but the inability of gravel to cope successfully with the elements and modern traffic in bad weather. Even in good weather one cannot be sure that a smooth gravel road on one day will be smooth the next, for loose gravel may be placed on it by the maintenance crew at any time, rendering it difficult and dangerous to use.

The gravel road suffers even more in comparison with hard roads for commercial vehicle traffic and from the standpoints of gasoline consumption and wear and tear on vehicles and tires. Sentiment and false economy aside, the gravel road simply is not suitable for use on primary roads.

HIGHWAY BRIDGE ENGINEERING

The highway bridge engineer has been somewhat neglected by the engineering press. While it cannot be said that there is any lack of appreciation of the importance of highway bridges, it is undoubtedly true that the great sums spent for highway paving have caused many to overlook the comparatively modest expenditures for bridges and, incidentally, to overlook the work of the bridge engineers. Then, too, the great paving operations have led to many innovations in construction methods and equipment of great news value and immediate economic importance. There have been few innovations in bridge building during recent years and so, what with one thing and another, the highway bridge engineer has not been granted the recognition to which he is entitled.

Attention is called to this fact as a preliminary to greater recognition of the bridge builder in this magazine. A number of articles are promised on interesting highway bridge construction jobs for early publication.

SIDE LIGHTS ON MUNICIPAL PAVING PRACTICE—RECENT WORK SHOWS MANY IMPROVEMENTS

By Harlan H. Edwards, C. E., City Engineer, Danville, Ill.

A survey of improvements made in a number of our representative cities within the past year shows that municipal engineers are consistently giving greater thought to the creation of smooth durable pavements at lower costs. They are also devoting more time to the study and introduction of details which make for increased strength in the placing of many of our city thoroughfares on a par with the state highways, as regards their riding qualities and permanence.

Confronted with the existence of many old wornout pavements which required resurfacing, and with the need for scores of new and substantial arteries of travel our engineers have met the public demand in various ways. Renewal of life by re-surfacing has been the favorite remedy for our old streets, the methods employed varying in different cities. Some replaced the old wearing surface with asphalt filled brick, others used one of the various forms of the bituminous pavement, while still others cast their lot with concrete, all, however, with the one idea of conserving what they already had, and adding what was necessary to obtain the desired strength. New pavements have consistently been made stronger to withstand the increasingly heavy traffic and have changed but little in design from the accepted standards.

Bituminous Mastic Cushion a Success

One of the most recent improvements in brick pavement design has been the investigation and approval of the use of the bituminous mastic cushion in place of the old troublesome sand cushion. Sand mixed with about 10% Tarvia B, a cold application tar product, forms a resilient, non-flowing, easily laid bed for the asphalt filled brick top, and makes possible a permanently smooth surface free from the little dips or low brick caused by the working of the old sand cushion through cracks in the concrete base. The section of the Bates Test Road built in this manner and having only a 5½ in. concrete base was the only brick paved section to come through the tests on the Bates road unscathed, and gave an undisputed recommendation to this type of construction.

Wide Joints Not Essential for Good Asphalt-Filled Lugless Brick Pavements

Considerable complaint has been voiced by various engineers and inspectors on brick pavement construction where lugless brick and asphalt filler is used, on account of the apparent difficulty encountered in filling every joint between every brick its entire depth with asphalt. They bewail the fact that the lug brick has been abandoned because the brick sometimes lie so close that the filler cannot penetrate between them. Careful consideration of the facts in the case, however, will reveal that the admonition "fill every joint from top to bottom" when cement grout filler is used, has been so well learned that the consideration of the real functions of the bituminous filler has been lost sight of.

Flexibility, cleanliness, and the elimination of expansion stresses are the greatest points in favor of the asphalt filler. The first and the last points were fulfilled by the sand filler, with which many of our oldest and best brick streets were constructed, and in which, incidentally, lugless brick were used. Protection of the edges of the brick at the joints, however, was not afforded by sand, and the item of cleanliness was not seriously thought of. Bituminous fillers, however, fulfill all the conditions demanded, and in addition have the advantage of reduction of wear at the joints, quietness, and cleanliness, which in these days of greater sanitation is an important item.

From the standpoint of permanent smoothness and continuity of suface as well as cleanliness, narrow joints are very desirable, for where brick are in such contact that even liquid asphhalt at high temperatures will not penetrate the joints, it is folly to worry about it. Since close contact reduces the cobbling or wear of the brick at the joints, it makes for smoother, longer lived surface and a lower annual maintenance cost to have the narrowest joints possible.

The supposition that bituminous filler produces a waterproof pavement is not true. An examination of many pavements at different intervals shows that the sand cushion or bedding course under the brick is always wet after a rain. It shows also that contraction of the surface in cold weather produced cracks between bricks and the filler which are sometimes large enough to admit a knife blade. Manifestly, then, the idea of waterproofness is erroneous and the need for filling every

joint, however small, with bituminous filler, does not exist.

It seems that many of us are prone to make a big fuss over little unessential things, while at the same time we disregard the bigger things which are really the controlling factors in determining whether or not the pavement as laid will give its proper service. Contrary to the characteristics of the cement grout filler, bituminous filler will not permit stresses which will "pop off" the tops of the brick or cause blow ups in hot weather if it penetrates but a fraction of the entire depth of the brick. It is not so essential that the sand or bituminous mastic cushion be such that it will not work up part way between the brick under the roller, and thus prevent full penetration of the filler the entire depth of the brick. Full penetration is desirable, but not so much so that it would warrant an increased cost or a sacrifice of wearing qualities of the pavement to insure it.

Building Adequate Crowns on Old Streets

Many of our old streets needing resurfacing have become so worn and flattened out by years of travel that new crowns must be built up, in order that proper drainage may be obtained, and that the appearance of the pavement may be enhanced thereby. In some sections of the street this means the use of from 4 to 6 ins. of material, but it is well worth the expense. In most cities the minimum thickness of the new surface is used at the gutters, marking the elevation of the gutter line every 20 ft. by chisel on the face of the curb. From this line the proper crown is teed in along the street, setting plugs, pins or bricks at the correct elevations along the center and the quarters to insure the obtainance of the required slopes. When such methods are used the resurfaced street has the appearance of an entire new job and is the pride of the property owners and citizens in general. Little objection is ever raised by these people to the expenditure of money, provided they can see that they are getting their money's worth.

Use of Salts in Concrete Increasing

The use of calcium chloride and kindred chemicals for accelerating the hardening and curing of concrete pavements and bases is increasing as the engineer appreciates the cost to the public of keeping their thoroughfares closed for indefinite periods of time. Dissolved in the mixing water or put in the drum of the mixer before materials are added, the flake calcium chloride becomes thoroughly incorporated in the concrete and greatly shortens the hardening period, enabling traffic to use the pavement in nearly half the usual time. Although a success in some places, the use of flake calcium chloride cast over the surface of the pavement for curing purposes has not become thoroughly established as standard practice, owing to the apparent bad effect of some impurity in the commercial product. Where absolute uniformity of covering is secured, this trouble does not usually manifest itself, but where lumps or small piles of the chemical are allowed to stand on the concrete, "rotten" spots often result. Further investigation may eliminate the cause of this trouble, so that the good qualities of this practice may be made available for all, and eliminate the expense of covering with wet earth, ponding, etc., and incidentally shorten the long period of curing so that the roads may be available to public travel. Of course, the use of this chemical in cold weather concreting has already become standard practice, so that

DRAINAGE OF STREET CAR TRACK PAVEMENT AT DANVILLE, ILL.
Left: Standing Water on Wood Block Pavement in Car Track. Every Passing Car Splashes Water on All Sides. Right: Track Drain in Place. Note Clean and Smooth Condition of Pavement.

road building operations, and especially those using central mixing plants, may be run well into the winter without fear of damage. The recommended amounts to be used are not as yet entirely agreed upon, but one authority recommends about 4% calcium chloride, while another claims that 2% calcium chloride mixed with 9% ordinary salt, the percentages being of the weight of the mixing water, gives the best results. It is hoped that experiments now being carried on will decide this question.

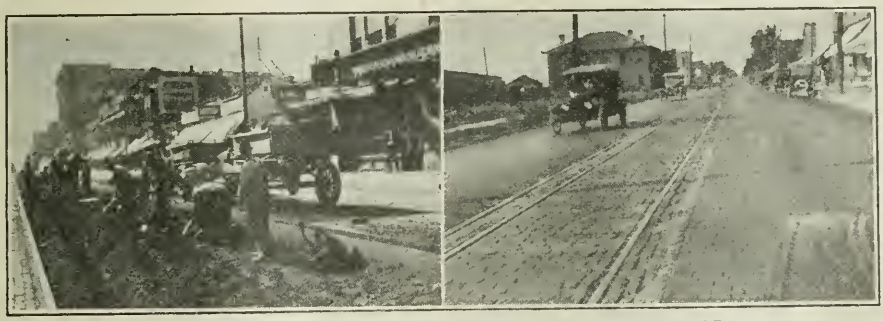
Important Details in Track Construction

Many cities are afflicted with poorly-laid street car tracks which are noisy, uncomfortable to ride over, and impossible to keep in proper repair. They are not only a source of damage to the traction company's rolling stock, but are also a source of great damage to the pavements in which they lie. Built with the idea of "saving money," their history has shown a large and unwarranted cost of upkeep—greatly off-setting the "saving" effected at the time of construction.

pools. The use of track drains to remove this water which is the cause of all of these troubles is very effective.

A drain which has proved inexpensive and simple of installation is shown in the illustration. Fitting as it does between ties and extending from rail to rail, it is necessary only to lay a line of vitrified tile from the drain to a sewer and pour concrete inside the drain for its floor, sloped to carry the water to the tile. The pavement is laid even with the surface of the drain casting, thereby causing no hump or uneveness whatever in the street.

Poorly laid track means quickly and permanently damaged pavements above it. Injury and destruction, however, is not confined to pavement in the track space alone, but is spread out into the street on each side by the continuous vibration and movement of the rails and ties under traffic. Structures not owned or paid for by the car company are damaged by this action also, and until the past few years no action has been taken



HEADER CURB CONSTRUCTION AT DANVILLE, ILL.

Left: Car Track Being Replaced, Note Header Curb—Concrete Header Curb. Note Difference in Condition of Car Track and Street Pavements.

Seemingly small details of construction oftentimes govern to a large extent the life of the track structure and also the life of the pavement above and adjoining it. Thorough drainage of the track structure is an essential part of such work. Surface water running along the flangeway next to the rail gradually finds its way into the track foundation, softening and reducing its bearing power. Settlement and damage is the inevitable result of such action if the water is not removed from the track and flangeway quickly. Standing water along the car track not only damages the track itself and the pavement adjacent, but it also has a potential damage to pedestrians who happen to come in contact with muddy water splashed by cars running through these

to confine the damage to the point of its origin. Substantial track construction eliminates all of these troubles and cuts out the source of many complaints against the street railway companies.

In cities where the car tracks are not well laid or have become in bad condition due to lack of maintenance, the damage caused by such poor construction is confined by means of a header curb on each side of the railway's right-of-way. This curb is in reality a little wall, protecting the city's pavement from damage by the movement of the tracks. It really separates the paving into three sections—the portion in and along the tracks and that on each side, thus confining the damage to the point of origin. It also acts as a retainer of the pavement foun-

dation, permitting the entire removal and replacement of the track structure without damaging the adjacent pavement.

The header curb is composed either of concrete, of a combination of concrete with steel angle paving guard, of creosoted wood block, or granite, and is usually 6 ins. thick and from 18 to 24 ins. deep, thus bringing the base of the curb well below the bottom of the track structure. It is usually concealed from view, yet it is there and functions continually.

The foregoing items are but a few of the many improvements which have been made, and are well representative of the more important items. It is well said that no structure is stronger than its weakest part, and pavement construction is no exception. It is true that many of the items mentioned constitute but a small part of the total cost of the work, yet the lack of such small items may eventually cause the destruction of the whole. It is impossible, of course, to prescribe standard details which would fit every case. Every job tackled is different from the preceding one in some respect, so that every detail of construction like every pavement has its own place. There is no one best practice, but rather the selection of the most suitable types of construction for the individual job constitutes the engineer's work and it is in his judgment in making this selection that his worth to the municipality is revealed.

DATA ON BRICK PAVEMENT CONSTRUCTION AT DETROIT, MINN.

By John F. Druar, of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn.

A very successful brick pavement has just been completed by the city of Detroit, Minnesota. Druar & Milinowski, Municipal Engineers, St. Paul, Minnesota, were the engineers in charge of this work and S. Birch & Sons Construction Company of Fargo, North Dakota, were the contractors.

The materials used on the work were of the best grade throughout, and every precaution was taken by the engineers to see that the specifications were rigidly followed. Mr. W. A. Vaughn was resident engineer on the work and had two capable assistants, William E Frank and R. J. Kewley, all of whom performed their specific duties in a splendid manner. Mr. Milinowski or Mr. Druar visited the work at about 10-day intervals throughout the construction. Great care was given the supervision inasmuch as a considerable amount of the pavement went on some newly filled water and sewer trenches. The concrete base of the pavement was reinforced over these trenches as was the curb.

There was a large amount of incidental work connected with the pavements, such as the re-location of catch basins on storm sewers, the moving of ornamental light posts, installation of electric conduits, steam lines and the mushroom center lights, some of which was due to the widening of the streets. The greatest width of a street, curb to curb, was 76 ft., while none of the streets are less than 36 ft. curb to curb.

The pavement was laid to conform to all requirements of the State Highway Commission as the city of Detroit will have a refund on that amount of pavement over which the state highway traffic passes.

The engineers made a report on this work, together with estimates of the cost of the various types of pavement in October, 1921, and the estimated cost of the various types of pavement for 27,705 sq. yds. of pavement, the necessary grading and curb and incidentals was as follows:

For 7½-in. one course concrete pavement, 1-2-4 concrete....$101,795.40
For 2½-in. asphaltic pavement on 6-in. concrete base..... 129,500.40
For 3-in. brick paving on 6-in. 6-in. concrete base 129,500.40
For 3½-in. woodblock paving on 6-in. concrete base 184,910.40

The bids were called for and opened on Feb. 14, 1922. The brick paving was selected for a total of 29,578.5 sq. yds. of pavement, the bid price on brick being $138,535.

The contractor started his work on April 16, 1922, and completed it at a total cost of $138,800 on Sept. 15, 1922, although he was handicapped for a month or so due to delays beyond his control, such as coal and railroad troubles.

The remarkable part of this work was the unusual price obtained by the City for brick paving, and although there was a considerable amount of extra reinforcing steel and changes to the grade and position of ornamental posts, sewer manholes and catchbasins, the total cost was only $265 over the bidding sheet figures on the letting of the contract.

In addition to the pavements put in by the City, the engineers supervised the laying of a considerable area or pavement

on the Northern Pacific R. R. Co.'s property and depot approach, which was completed under the same specifications.

The comparative bidding costs on nine different pavements represented were as follows:

TABULATION OF LOWEST BIDS RECEIVED FOR PAVEMENTS AT DETROIT, MINNESOTA, FEBRUARY, 1922

Kind	Base	Top	All Else	Total
3 -in. Penetration Macadam (Tar)	$1.56	$1.35	$.71	$3.62
2 -in. Topeka Type (Native Lake)	1.76	1.58	.41	3.75
2 -in. Bitulithic (Native Lake)	1.60	2.45	.65	4.70
2½-in. Sheet Asphalt (Native Lake)	1.76	1.86	.40	4.02
3 -in. Brick (Pitch Filler)	1.15	2.83	.64	4.62
3 -in. Wood Block (Pitch Filler)	1.76	2.90	.40	5.06
3½-in. Wood Block (Pitch Filler	1.76	3.20	.40	5.36
7½-in. One course Gravel Concrete	2.20	...	.44	2.73
7½-in. One course Stone Concrete	2.57	...	.61	3.18

All Bases 6-in. Gravel Concrete. Above figures are per sq. yd.
Curb (gravel) .48 to .88 per linear foot.
Combined curb and gutter (gravel) .74 to 1.42 per linear foot.

From this, you will see the extreme low cost of the work to the City, which will be analyzed still further in the successful contractor's bid prices which follow:

Excavation per cubic yard, $.85. This included either filling the excavated material back of the curb to the boulevard or a haul of not to exceed 2,000 ft. to the dump. For any greater length of haul, an overhaul charge of 3 cts. per cu. yd. per 100 ft. was allowed.

1-2½-5 concrete in place at $9 per cu. yd.

Metal reinforcement $.05 per pound in place.

Miscellaneous iron and steel $.07 per pound in place.

8-in. vitrified sewer pipe drains in place $.65 per foot.

Changing elevation of sewer and heating manholes $3 each.

Changing line and elevation of ornamental lights $11 each.

Traffic mushroom signals in place at street intersections $45 each.

3-in. fibre duct in place $.25 per foot.

Plain concrete curb 6-in.x18-in., $.48 per foot.

Concrete 6-in. base of pavement in place, 1-2½-5 concrete, washed gravel, aggregate $6.90 per cu. yd.

3-in. brick pavement with 1-in. sand cushion and pitch filler sanded surface, $2.83 per sq. yd.

4-in. concrete sidewalks repaired, $.25 per sq. ft.

From the above, the reader will see that the contractor did not have much margin on the work, especially when you take into consideration the following facts:

Brick

All brick originally was contracted for from the Purington Brick Company, Galesburg, Illinois, but owing to coal strikes and the car situation, it was necessary to have the balance of the shipments come from the Alton Brick Co., so that about two-thirds came from the former company and one-third from the latter.

Owing to the State Trunk Highway reimbursement, it was necessary to have records of all tests on brick, sand, gravel, bituminous filler, cement, etc. Therefore, the engineers arranged for making the tests by the State Highway Department at the University of Minnesota under Mr. F. C. Lang, Engineer of Tests, and as a matter of courtesy to Mr. Lang, the Illinois Highway Department sent an inspector to the brick yards to test the brick and see them loaded. The cement tests were made at the Q. A. Hall Laboratories of St. Paul, Minnesota. The reports of tests on all material entering into the work were sent to the engineers, Druar & Milinowski for careful checking. Tests were also made on concrete cylinders cast from time to time from the actual street materials. Sand and gravel was obtained from a local pit about one mile from the work.

The contractor opened this pit and equipped it with a modern washer of the reciprocating type. This washer was also equipped with two bins, one for sand and the other for gravel. The oversized gravel, of which there was no great quantity, was discharged over the side of the pan and removed from time to time in wagons. The wash water was discharged down a long flume onto low lying ground leased for the purpose by the contractor. The gravel was not very dirty but did not average over 25% to 30% gravel and there was a large amount of material handled for the amount of washed gravel obtained. The wash water was piped from the end of the city mains, a distance of 1,600 ft. through 4-in. wrought iron pipe and about 200 gals. per minute were used while the washer was running. One of the engineers was stationed at the pit, and saw to it that proper proportions of sand and gravel went in each load. This

gravel and sand was used in the base and in the curb, and the sand was used for the sand cushion. Tests were made daily and a random test sheet shows as follows:

Retained on 2¾-in. screen	0
Passing 2¾-in. screen	100
Passing 2 -in. screen	89.8
Passing 1½-in. screen	74.1
Passing 1 -in. screen	47.7
Passing ¾-in. screen	33.1
Passing ¼-in. screen	2.3
Passing ⅛-in. screen	2.0
Percent loss by abrasion test	5.4
Percent shale	0
Percent slate	0

Sample test of the sand was as follows:

Percent passing 2 -in. screen	100
Percent passing ¼-in. screen	93.5
Percent retained on ¼-in. screen	6.5

The part passing the ¼-in. screen showed:

45.7%	passing No. 20 sieve
7.5%	passing No. 50 sieve
2.2%	passing No. 100 sieve

The color plate test was No. 1. The loss by elutriation was 1.38. The tensile strength of 1 to 3 mortar showed an average of 373 in seven-day test and 457 in the 28-day test as compared with 297 and 400, respectively, for Ottawa sand mixed in the same proportion and with the same cement.

The accepted bid was $1.15 per sq. yd. of 6-in. concrete base; $2.83 per sq. yd. of 3-in. brick top, including the sand cushion and pitch filler, all complete in place. The cost of all curbs, manholes, traffic lights, electric fibre ducts and similar miscellaneous construction items amounted to $.64 per sq. yd. of paved surface or a total of $4.62 per sq. yd.

The price of the curb was $.48 per linear foot.

The pitch filler was an oil asphalt furnished by the Standard Oil Company. Samples of this were taken both from the cars and from the kettles on the street. The total amount of asphalt filler used was 355,000 lbs., or about 12.1 lbs. per sq. yd. of brick surfacing.

An engineer was stationed at the mixer to see that the proper proportions of cement and water were used in the concrete and the resident engineer saw the concrete placed and brought to the finished grade of the base. The base was allowed to stand and was kept wet for two weeks before the 1-in. sand cushion and brick was placed.

On the completion of the work, the pavement was well sanded and the resulting surface even during a heavy rain did not show a puddle. In other words, the surface of the pavement was practically perfect, and the Council and citizens are well pleased with the work.

While the total cost of the pavement was $138,800, the assessment was spread at $150,216. This allowed for the engineering and other incidental expense and a fair amount left over in the paving fund. As the City at large put in the storm sewers, the whole cost of the pavement was assessed against the abutting property, including the intersections, and in accordance with the law, this amount may be paid in cash or over a period of 20 years. The following charge was made per foot front for the various widths of pavement:

36-ft. pavement	$13.14 per front foot
42-ft. pavement	15.33 per front foot
44-ft. pavement	16.06 per front foot
46-ft. pavement	16.79 per front foot
48-ft. pavement	17.52 per front foot
56-ft. pavement	20.44 per front foot
76-ft. pavement	27.74 per front foot

About 10 per cent of the cost of the pavement was paid by the N. P. R. R. Co. and the same amount was paid by the County for paving in front of the Court House and the City paid for their frontage.

In all, about 75,000 brick were culled in the street during the laying. Brick was rejected if an average of 23% by weight or an individual loss of 25% by weight was found. Thirty bricks were supplied by the contractor from each carload and of these the laboratory selected 10 for the test. The average tests shown throughout totaled about 20.6% for rattler loss by weight. The bricks averaged 8½-in. long x 3⅞-in. wide and 3-in. deep and were lugless.

In conclusion, we wish to say that brick paving in Minnesota has not been pushed as hard by the Brick Association as might be, owing to the high freight cost of shipping in the brick. There is no satisfactory paving brick made at present in Minnesota.

It is estimated that this pavement will still be in good condition after 40 years of service and under these conditions, if low prices such as given here could be had, there is no reason why brick pavement should not be used extensively in the next few years in this section of the country.

RELATION BETWEEN BITUMEN AND FINE MINERAL ASPHALTIC MIXTURES

By Hugh W. Skidmore, Consulting Engineer, Chicago Paving Laboratory, Inc., 160 N. Wells St., Chicago, Ill.

While the design of asphaltic mixtures assumes the use of materials complying with certain requirements, such as grading of the sand, hardness and shape of

the sand particles, fineness and absorptive ability of the filler, together with the well known chemical and physical tests applied to the asphaltic cement, especially the penetration test which bears a particular relation to the pavement under the various conditions that may be imposed; there are permissible ranges within which the engineer may work safely and still fall short of the ideal in one or more of the requirements. The all important item is that he shall know within what limits he may vary the materials without detracting materially from the durability of the resulting composition. This fact is indelibly impressed upon the student of pavements when he notes that in localities where practically ideal materials exist, pavement failures occur because of violation of some fundamental principle. Failures do not occur without cause and the real cause of every failure is capable of determination.

Most of the failures which do occur in asphalt pavements are not due to any inherent defect in the mixture, but, are those common to most all pavement types, such as foundation failures, poorly drained subgrade, failure properly to replace the pavement over openings and others of a purely extraneous nature. This article will not discuss such failures as these, as they are usually the result of such flagrant violations of good engineering and sound economy as to be entirely without the realm of specialized knowledge and experience.

Defects Developed by Modern Traffic

Defects which develop in asphalt pavements under modern traffic conditions, consist almost entirely of surface displacement or movement, cracking and rare instances of ravelling. Cracking which may be attributed to the mixture itself is not common. The great majority of cracks in asphalt laid over rigid foundations is simply surface reproduction of cracks in the base. By "great majority" in this connection, I mean 95% or more. I have had occasion to investigate this feature at various times and each time I have been more impressed with a statement made to me several years ago by a man who had spent some thirty odd years laying asphalt pavements, to the effect that 99% of cracks in asphalt pavements were simply surface evidence of the cracking of the base.

Distortion Under Traffic

Distortion of the mixture under traffic is of two kinds, forward displacement and lateral displacement. The latter occurs on thoroughfares which are subjected to swiftly moving traffic, best described by the term "boulevard traffic." Forward displacement is developed under heavy traffic moving at a comparatively slow rate. There is another kind of distortion which is not due to any inherent defect of the mixture; this is the rutting which may be noted near the curb on asphalt streets which are constantly subject to standing motor car traffic. The drippings from the automobiles are responsible for this. In reality asphalt is not at its best under such a condition, and I am of the opinion that engineers should design the pavements in such cases with a brick or concrete strip next to the curb within the parking area. If the parking may be transferred alternately from the sides to the center, the effect of the drippings upon the asphalt will be greatly relieved.

Mixture Displacement

As mixture displacement has become prevalent and is by far the most objectionable defect that has developed under the changed traffic conditions during recent years, this discussion will be concerned largely with some of the principal causes of mixture distortion together with some of the cures which have been evolved through the medium of actual experience as well as theory.

Undoubtedly the most fertile cause so far as the mixture composition alone is concerned, is the use of too much bitumen and insufficient fine mineral or filler. Density of the mixture is of primary importance, and although it is not the only factor which affects the stability of the composition, high density does more to insure freedom from displacement than any other one thing, when it is accompanied by bitumen content just sufficient to coat the particles without any excess.

Securing Maximum Density

In order to secure maximum density, the first consideration is, of course, the reduction of voids to a minimum by means of a well graded aggregate. But, grading alone will not guarantee the desired result. It must be accompanied by the use of an asphalt cement of just as low a penetration as is possible without danger of cracking, having in mind the traffic to be carried; the rule being that the heavier and denser the traffic, the lower the permissible penetration, within certain limits. Climate is not nearly as important a factor in determining the penetration limits as is the traffic. In addition to this element, the mixing must

be very thorough and no segregation of the aggregate should occur as it passes from the storage bins to the mixer box. To insure uniformity, weighing of all materials must be accurate. And last, but by no means least, the laying operations must be such as to eliminate any possibility of mechanical defects which might afford a starting point for displacement. This will include proper distribution and raking of the hot mixture; good construction joints and other minor items, and above all, compression. The hot material is compressed to its ultimate density (practically speaking) under the first application of the roller. For this reason it is imperative that heavy rollers be used, and for the first rolling the three-wheeled type will be found to give much more satisfactory results than have been generally secured with tandem rollers. There are two chief reasons why this is true; the applied weight is greater per lineal inch of wheel width without any increase in the total weight of the roller; and, there is no crowding action under the roller, as with the three-wheeled type one wheel does not follow the other two in the same track. Three-wheeled rollers do not mark the surface by repeated application as much as the tandems do, for the reason that the compression is much greater under the first application. It is true that this type of roller cannot be handled as easily as the tandem and, therefore, its use should be confined to rolling in one direction without twisting, and should then be followed by tandems which respond more readily to cross-rolling, angle-rolling, etc.

Examples of Defective Mixtures

It is thought that comparison between actual examples of mixtures which have proven defective and others which have demonstrated their ability to withstand the traffic forces will prove of more value than a discussion of hypothetical cases, and for this reason a number have been selected from the records of actual investigations.

The first example of defective mixture is represented by two analyses of rolled sections. This pavement has been in service only a few years, carrying heavy arterial highway traffic in the vicinity of Chicago. The effect of heavy trucks during hot weather is apparent at a glance. This excessive rolling occurred only in certain sections of the road, and by no means could be called general; however, after driving over two or three sections like this, the occupants of the car would have a rather poor impression of this particular piece of asphalt pavement.

Bitumen	11.7%	12.0%
Mineral passing 200 mesh	12.7%	12.5%
Mineral passing 80 mesh	14.1%	13.0%
Mineral passing 40 mesh	27.5%	25.5%
Mineral passing 10 mesh	9.0%	8.0%
Mineral passing 4 mesh	18.0%	23.5%
Mineral passing 2 mesh	7.0%	5.5%

This mixture was apparently laid under a specification for Topeka type or a modification of the same, and it will be seen from these two analyses, taken from two different rolled sections, that about 3% too much bitumen was used. Any comment relative to the grading of the aggregate in this case is superfluous, since the most perfectly balanced grading could not possibly prevent distortion of such a mixture under heavy or boulevard traffic.

Another example of a badly rolled asphaltic concrete pavement is represented by the following analysis of a sample taken in an Iowa city:

Bitumen		11.2%
Passing	200	13.9%
	80	12.0%
	40	19.8%
	10	25.2%
	4	15.5%
	2	2.4%

Specific gravity of mixture—2.32

Again we find the bitumen entirely out of proportion. The specific gravity in this case seems relatively high and indicates good density; but, the virtue of density is destroyed by the excess of bitumen, which bears out a previous statement that density must be accompanied by the proper amount of bitumen. The underside of this sample was worn smooth from slipping on the concrete base.

Another example of rolled mixture is given below, and in this case a somewhat different condition arises, as the bitumen content would not have been excessive had the fine mineral been sufficient:

Bitumen		7.7%
Passing	200	7.1%
	80	4.0%
	40	11.6%
	10	18.8%
	4	33.3%
	2	17.5%

The most obvious defect in this mixture is the shortage of 80-mesh particles, which undoubtedly detracts from the stability of the structure.

Rutting may occur in a mixture which would ordinarily be considered fairly good for normal or moderate traffic. The case of the sheet asphalt pavement which rutted badly in two years of service under boulevard (or swiftly moving) traffic as given below, will serve to illustrate this fact. The first of these analyses is of a sample from a badly rutted section

and the second is from a portion which showed slight rutting at the end of four years, both from the same street:

		No. 1	No. 2
Bitumen		11.3%	11.7%
Passing	200	10.9%	14.1%
	80	23.4%	26.5%
	40	34.7%	33.9%
	10	18.2%	12.7%
	8	1.5%	1.1%
Specific gravity		2.14%	2.18%

Asphalt cement of 60 penetration used.

The higher gravity of No. 2 is easily accounted for by the fact that it shows a much more balanced grading than No. 1. While No. 2 carries slightly more bitumen than No. 1, the grading of the aggregate and the presence of more filler explains why it did not rut as badly as No. 1. Undoubtedly the penetration had a great deal to do toward encouraging the distortion of this mixture, as the pavement is not shaded at any period of the day. The penetration in this case should have been about 35 instead of 60.

Open binder had been used on this work, as was evidenced upon removing the samples; and at the time the samples were taken the concrete base was very damp, likewise the underside of the binder showed the effect of water action on a porous mixture to the extent that some of the stone was almost clean and the mixture crumbled readily in the hands. These facts concerning the binder should be stresed here for the reason that so frequently this very important integral part of an asphalt pavement is given only passing, if any, attention to speak of; whereas it should be just as carefully designed as the top mixture. While the binder permits of wider working limits as to grading, it must be well closed and dense, with no excess of bitumen. Also the coarse aggregate should be selected with a view to providing maximum interlocking of particles; in other words, uncrushed gravel will not produce as stable a mixture as can be secured by the use of 50% or more of crushed particles.

An interesting analysis, of an 8-year old sheet asphalt pavement from an Illinois city, is given below in order to illustrate the effect of a surplus of material of any one size upon the density of the mixture:

Bitumen		10.0%
Passing	200	15.2%
	80	45.6%
	40	10.7%
	10	.9%
	4	7.6%

This pavement cracked as might be expected from the shortage of bitumen with respect to the amount of mineral passing the 80 and 200 screens. The specific gravity of this mixture was 2.07, which shows relatively low density.

Now in comparison with the foregoing examples of mixture which have failed to give good results under the traffic which prevailed, a few analyses of mixtures which are giving excellent results will be cited with notations appertaining to such local conditions as are peculiar to each. The first example is two typical analyses of a sheet asphalt mixture designed for heavy traffic on a through street in the business section of a busy city in Michigan. This street carries the through trunk line traffic between Detroit and the Lake Michigan region.

Bitumen		10.4%	10.5%
Passing	200	17.7%	20.4%
	80	28.2%	25.3%
	40	32.2%	31.1%
	10	9.5%	11.7%
	4	2.0%	1.0%
Sp. grav.		2.18%	

These two samples show the extremes of grading during the entire progress of this work, and it will be seen that the mixture was indeed very uniform; about the only variation being in the percentage passing the 200 screen. This was due to the fact that the fine sand which was used in combination with a coarser one, varied from time to time in this particular. The sample showing 17.7% passing the 200 screen apparently contained no 200 sand, as this percentage agrees with the amount of filler required on this work; while the other sample appears to have carried over a little very fine sand. This work was laid on close binder carrying 35% of sand and 5.5% of bitumen. The foundation is an old brick pavement. Initial compression was secured by means of a three-wheeled roller.

Two other typical analyses are given from work in the same city for the purpose of showing what changes were made in the bitumen content to accommodate the various traffic conditions which obtained; the first being for moderate traffic and the second for light residential traffic:

		No. 1	No. 2
Bitumen		11.1%	11.6%
Passing	200	17.4%	20.9%
	80	25.1%	30.8%
	40	29.0%	30.8%
	10	15.1%	11.0%
	8	2.3%	1.3%

Numerous other mixtures both good and bad might be cited; and with a vast amount of such data for comparison, one is immediately impressed with the fact that in most cases pavement distortion under heavy traffic is due to the use of too much bitumen, insufficient filler, or a

combination of both. There are other causes of displacement, but they are much less common than this very important ratio of bitumen to fine mineral.

One case of very serious forward movement of sheet asphalt on a heavy traffic street in a large city, which I was called upon to investigate, was found to have been due to the fact that in resurfacing an old brick pavement (without binder course) the surface of the old brick had been heated and painted, while hot, with a cut back asphalt cement, in which the cutting agent failed to completely volatilize before the top was applied. This caused a fluxing action on the underside of the sheet top, producing an excellently lubricated plane of contact, which made rolling of the sheet a certainty. This condition was enhanced by the fact that condensation of moisture on top of the hot brick when the cold paint coat was applied prevented adhesion of the paint to the brick.

High Filler Content Now Essential

Filler content, which a few years ago would have been regarded as unnecessarily high, is essential in mixtures which are to be subjected to considerable traffic. This must be supported by a well graded sand, and the bitumen content must be consistent with the weight and volume of the traffic; as low as possible for heavy and dense light weight traffic, increasing as the weight and volume decreases. For a given bitumen content, the more fine mineral the mixture contains, the thinner will be the film of asphalt coating each particle, thereby reducing the possibility of the bitumen functioning as a lubricant during hot weather. An excessive amount of any one size, of even fine mineral, is of course dangerous, and constitutes about the only thing to be guarded against in designing a mixture with relatively high percentage of fine particles.

The foregoing paper was prepared by Mr. Skidmore for presentation before the 1923 meeting of the Iowa Engineering Society.

BENEFIT DISTRICT ASSESSMENTS FOR ROAD IMPROVEMENT

By M. W. Furr, Associate Professor of Civil Engineering, Kansas State Agricultural College, Manhattan, Kansas.

During the past four years the United States has expended approximately two billion dollars for rural road improvement. At the present time, there is some popular resentment against further expenditure for a unified system of highways because of high taxes. Notwithstanding the moneys spent for road improvement, a complete analysis of individual tax bills will reveal that only a small per cent of the aggregate is for good roads, and that special assessments are almost insignificant when benefits accruing are considered. However, protests are being made against the benefit district assessment method of partially paying for road improvement to the extent that building programs are sometimes retarded.

For several years municipal improvements have been partly or entirely financed by assessment against the abutting or adjacent property. State Legislatures and Courts have specifically recognized and passed repeatedly upon the theory of assessments according to benefits as equitable. Several methods have been satisfactorily used for the grading of assessment in order to distribute the cost of the project to the property in the district benefited.

The Area—Zone Method

The area-zone method is doubtless the most satisfactory for financing street improvement in which the per cent of zone benefits vary as the ordinates to a parabolic curve constructed on symmetrical axes, with the length of the abscissa equal to the width of the district. Data on the question as to whether or not the benefits accrue in this ratio is lacking. From the above about 72% of the cost of a pavement is assessed against the abutting property lying within one-half the width of the district, and 28% of the remaining one-half width. The districts are generally divided into four of six parallel zones and the weights used range between 45 to 60, 30 to 40, 17 to 20 and 5 to 13 per zone, respectively. The questions that arise are:

1. Can this plan of assessment equitably be applied to rural districts?
2. If so, where do the benefits fall and in what ratio do they feather out?
3. What per cent of the total cost should the district bear, and
4. Should a benefit district bear a fixed percentage of the total cost regardless of the type of road, or should it vary indirectly with the type or importance of the road?

Community Benefits

The question of community benefits accruing can not be denied as this is strongly apparent when a locality served with

railroad facilities is compared with one not so favored. In the same way the construction in any community of adequate highways of year-around serviceability for motor transport confers a real benefit to a community. A part of the cost of such an improvement might therefore be properly and equitably paid from a taxation of the district served. The possibility of the district profitably utilizing the facility will vary greatly wth the nature of the industries in the district and it is doubtful if any fixed percentage to be assessed as a general tax would be equitable for an area as large as a state. Differences in the assessed valuation of land, however, will tend to equalize taxation to a great extent even though the rate of taxation is uniform. There is also a direct and tangible benefit conferred on agricultural land by construction of good roads contiguous thereto. Lands on good roads are worth more than those not so situated and will actually sell more readily at a higher price. The land can be operated to show much better profits if located on improved roads, because of the facility with which it can be operated. Therefore, a certain part of the cost of a durable improvement can rationally and fairly be assessed against such lands. The percentage of the cost to be assessed is not easily determined. To my knowledge, two states, namely, Iowa and Kansas, assess the benefit district for 25% of the cost of the improvement.

Most Direct Benefit to Road Users

It goes almost without saying that the most apparent and tangible benefit from road improvement comes to those who travel the highway for business or pleasure and since about 95% of the tonnage on our highways is made up of various classes of motor vehicles, it follows that to them the benefit is most apparent. The cost for fuel, vehicle upkeep and the saving in time on improved roads are real and measurable benefits. Some tests of a preliminary nature were made at Ames, Iowa, to determine the differences in gas consumption on various types of surfaces. Very conservative conclusions were that 15% less fuel is used when traveling a high type surface. It is sufficient to say, therefore, that motor car operators will save $30 to $50 per year on fuel alone, a saving that can profitably be invested in road construction and maintenance. The amount that is added to the cost of the road because it must accommodate motor truck traffic can hardly be taxed against others than owners of motor trucks and it seems probable that in the future both motor trucks and passenger vehicles will be required to bear an increasing portion of the cost of road construction and maintenance.

For the above reasons it seems to me that a flat assessment of 25% of the net cost against the benefit district is excessive under the present conditions, especially for state road improvement where the pavement is designed for inter-city truck traffic. This does not mean necessarily that the percentage apportioned to the district is too high, but that the net cost against the district should be first reduced by deducting an amount to be borne directly by motor car operators. Our County Commissioners, assembled at Topeka in November, favored a state bond issue of $60,000,000, which obligation, if authorized, will be borne by motor vehicle revenues. Within ten years a state wide system of 6,575 miles of road can therefore be constructed without additional burden to the taxpayers.

Benefit Districts

The benefit districts in Kansas are generally less than two miles in width on each side of the road project to be financed. In sectionized country it is generally better to let the district feather out on a parallel line at the one-half mile point, thus fixing the width at 1½ miles. The reason for this is obvious. The original arrangement for land classification in Kansas is as follows: (1) CLASS A, all land bordering on road project. (2) CLASS B, all land whose nearest corner is one-half mile from the road project. (3) CLASS C, all land whose nearest corner is one mile (by passable road) from road project. (4) CLASS D, all land not included in Class A, B or C. (All parcels of less than 40 acres, and all railway sidings and station grounds are to be classed as the quarter section in which they are located. All railway main line right-of-way to be classed in Class D).

Method of Figuring

In the first method of figuring, the relative benefits are assumed to accrue in the ratio of 45, 30, 17 and 8 per zone, respectively. The uniform tax factor is determined by dividing the total tax to be raised by the summation of the products of the zone valuations multiplied by their respective weights, and the zone tax rates are then found by multiplying the uniform tax factor by the respective zone weights. Individual assessments are

found, then, by multiplying parcel valuations by the zone tax rate.

The second method of figuring is identical with the first except that zone areas are used and the tax rate per acre similarly determined.

A third method which is similar to the second method, but with broader application, has been recommended for use by the Kansas State Highway Commission. The acre is taken as the unit, and the land is classified in zone 1, 2, 3, 4, etc., for distances of one-quarter, one-half, three-quarters, one mile, etc., from the road. The unit area is assumed to receive 100%, 80%, 70%, 50%, 40% and 30% benefit, respectively. Relative weights now become 10, 8, 7, 5, etc., and each zone assessment factor is found by dividing the product of the zone weight multiplied by the total tax to be raised by the summation of the product of the zone areas each multiplied by their respective weights.

For comparison of results of the three methods of figuring see the accompanying table. Principal data taken from Gravel F. A. P. No. 2, Labette County, Kansas; 25% of net cost to be raised is $11,863.74. Approximate cost per mile at $9,600; valuations taken from records of county clerk.

			—Assessments—		
	Valua-	Acre-	1st	2nd	3rd
Zone	tion	age	Method	Method	Method
1	1555	40	$46.80	$58.53	$50.42
2	1555	40	31.19	39.02	40.33
3	1555	40	17.68	22.11	35.29
4	1555	40	8.32	10.41	25.21
1	3905	80	117.54	117.07	100.84
2	2900	80	58.17	78.04	80.67
3	2590	80	29.44	44.22	70.59
4	3805	80	20.36	20.81	50.42

For further comparison the following data pertaining to paving F. A. P. No. 1, was submitted by Ira E. Taylor, County Engineer of Mitchell County. The assessments were determined by Method No. 1. Land and improvement valuations were placed by a board of appraisers. This pavement cost approximately $45,500 per mile with a total district apportionment of $76,267.39. The relative benefit weights assigned to the zones in this example were in the ratio of 45, 30, 20 and 5 and the assessment per zone per $1,000 assessed valuation computed to be $44.89, $37.22, $23.23 and $10.26, respectively. Railroad right-of-way was assessed as private property in whatever zone it was located. Under this method of figuring the approximate average assessment per acre per zone would rate at $4.80, $3.90, $2.20 and $1.00, respectively.

Point Method Used in Iowa

The point method of figuring is used in Iowa which, in my judgment, is a very commendable method. The Board of Apportionments are instructed to rate all parcels under the heads of (1) Market value (one point is assigned for each $25 valuation per acre), (2) Proximity, (3) Accessibility, (4) Productivity, and (5) Location. The total points per zone generally sum up so that the zones are assessed 41%, 28%, 18% and 13%, of the net total district apportionment, and for a graveling project a one-acre tract would be charged $2.10, $1.50, $0.97 and $0.68 per zone, respectively.

By careful comparison of the results obtained by distributing the assessments by the three methods mentioned above, it will be noted that the first method cannot readily be compared with the others because of variation in the valuations. The results obtained by this method will be consistent with the general tax assessments; however, adjacent property of the same acreage will be assessed differently. Railroad property was originally incorrectly classified but this has been adjusted in the present plan of figuring; namely, the third method mentioned above.

Insofar as the benefit assessment source of revenue is concerned, I believe that the public contention is because of the seemingly inequalities, rather than a criticism of the amount expended in this way for highway improvements. What then, is the equitable method for distribution of cost,—who is to pay and how much, or what percentage of the total expenditure for good roads is to be disbursed by the different sources of highway revenue?

The foregoing paper by Professor Furr was presented at the meeting of the Kansas Engineering Society at Topeka on Dec. 14, 1922.

EXPERIENCE WITH CITY MANAGER GOVERNMENT AT SACRAMENTO, CALIFORNIA

By C. L. Seavey, City Manager, Sacramento, Calif.

In Sacramento, a year ago the first of last July, the new charter took effect, putting in a city manager as the responsible head of the administration of the city affairs. Generally, the duties of the city manager included and took over the executive functions of the city. There

were, in a few instances, omissions in the powers of the city manager in Sacramento that may be remedied or may not, in the future, which interrupt, to a slight degree, at least, the ability of the city manager to control all things in the executive end of the city's affairs.

I was nominated and selected by the City Council about a month before the new charter took effect—the latter part of May. I immediately got hold of a person who had had a good deal of experience in both municipal and state affairs. from the standpoint of organization, and, together with him and one whom I had selected to take the office of City Comptroller, we made a survey of the existing organization in Sacramento at that time, and built up a new organization in accordance with the provisions of the new charter, and in accordance with our belief as to what the organization should stand for.

Force Cut, Salaries Increased

In so doing, we eliminated from the payroll of the City, taking effect as of July 1st, something over $43,000 in salaries alone. By that I do not mean that we lowered salaries. In fact, we lowered no salary; we raised many salaries, and some of them were raised very considerably. But, as a net result, we saved about $43,000 in annual salaries in reorganization. And since the first of July a year ago, we have saved additional amounts above the original $43,000 in the salary item. It was very gratifying to us at the end of the year's period that it was demonstrated that our original survey was within reason, and practically what was necessary in carrying on the affairs of the municipality.

As to what we have accomplished in Sacramento, I do not speak in any vain way, because it was there to be accomplished, and was rather easily done. What we accomplished, has been accomplished in nearly every municipality that has changed to the manager form of government. And to a great extent the reason for the accomplishment is that it is a better form of municipal government than the others. To my mind it is the best form of municipal government, both theoretically and practically, that has ever been attempted in the United States.

The first year we reduced taxes by approximately $123,000, and provided for more actual work to be done in the way of street improvements and street cleaning and things of that kind, than had been done before.

At the beginning of July, 1921, that being the middle of our fiscal year, we found a deficit of something like 20% in the available funds of the municipality. That is to say, for the remaining six months we had to run on about 40% of the year's appropriation, and the records which we kept showed that we accomplished more work in proportion with that 40% than had been accomplished on the 60% in the first half of the fiscal year.

That again is not necessarily a matter of credit to any individual. I ascribe the largest share to the fact that the funds and the operation of the city's affairs could be handled more easily, more directly, and more economically, because of the form of government, because there was no overlapping of departments, because there was actual, absolute coordination between all the departments, for the reason that there was direct responsibility to one head on the part of all city heads of departments and city employees.

And there was no question about what that meant. It meant that we got results for every dollar expended. And results were what we were looking for. We were not looking in any way for any political manipulation or machination. That is one of the things that cannot be avoided in other forms of municipal government. There is no use talking about it, it is absolutely necessary in some forms of government, even to accomplish good in the government, to manipulate politically, and that is always at the cost of efficiency and economy in any government.

At the end of the first year, which was the first of July last, when we had operated six months under the old budget and six months under the new budget, which was drawn after we went into office, I found that we had actually operated a year for $103,000 less in operating cost of the same functions of the City's affairs, than the government had been operated the year previous. And the records show that, as I have indicated before, we have accomplished more actual work, more streets repaired and such things, than the year previous. That again was because there was the possibility of a properly working organization.

We reduced the fire hazard in Sacramento. The fire losses were reduced 80% in the year. About a year ago last July, a survey of the City was made by the fire

department, which had not been made for years, and a consistent follow-up in fire prevention was put into effect, and to a large extent, I believe, was responsible for the very small percentage of fire loss in comparison with that of previous years.

Moral Questions

We have had our troubles. In the police department particularly, I find the opening for trouble for a city manager. The moral questions that must be handled through that department are quite a problem—they are a problem in any city. But we have accomplished considerable there, I believe, because of the fixed responsibility and the direct action on the part of the department through a responsible head. In fact, I know that we have practically eliminated the selling of drugs, where they were being sold promiscuously over a year ago. That has resulted in the reduction of petty crime, a big reduction in petty crime, in Sacramento.

The matter of liquor enforcement is another very difficult thing, because, in the minds of many people, it is not a thing to be desired entirely; and where you find in the public mind a non-desire or undeveloped desire to believe in a certain law that is on the books, it is of course impossible properly to administer that law. And yet the outward evidences of that have been eliminated, to a large extent. I might put it this way, that what might be called the vulgar and open evidences of it have been largely eliminated from the streets of Sacramento where they were very evident prior to the new administration.

We offered for adoption a little Volstead Act, but the people did not want it. So we went ahead the best we could with such means as we had at our hands, in co-operation to a certain extent with the Federal officers, unsatisfactory to a large degree, but we simply hammered away. You all have those problems, and probably the problem is just as difficult with you, and more difficult where you haven't the manager form of government.

We took over the garbage collection in Sacramento, and in the first year of operation we have put it on a paying basis, and from the operation of the garbage department, based on the charges that were in existence before the City took it over, we have made a saving. We netted a saving of a little over $8,000 in the first eight months of 1922. We purchased equipment at a cost of about $12,000, and by the end of 1922, we expect to have nearly if not wholly eliminated the cost of the equipment, and to have conducted the department in a manner practically satisfactory to the City. In evidence of this, before we took it over, the complaints from garbage collections were coming in at about the rate of 100 to 110 a day. They are now coming in, and have been for several months past, to the extent of 10 to 15. We never expect to eliminate them, but we believe we have reduced them very appreciably, perhaps to a minimum.

In the way of legislation, the Council has put over some excellent municipal ordinances, perhaps one of the best milk ordinances of any city in the state. There has been put into effect a traffic ordinance from which remarkably good results are coming, and our zoning ordinance is now nearly through its initial hearing. We have also followed stricter building restrictions, and they have proven that they were sadly needed.

General Observations on Manager Form of Government

The history of the operations in Sacramento, as I said, has been quite similar to that in other cities in the United States and Canada, where they have this particular form of government. To my mind, there has been a remarkable proof of efficiency in the growth of this form of government, proving it to be a more practical form, and better form for municipalities, than others that have been attempted. It has demonstrated by its growth that there is real merit in the method. Since 1913, nearly 300 cities, either by charter or ordinance, I think about 200 by charter and a ltle less than 100 by ordinance, have adopted this form of government. This is a remarkable record of growth in the establishment of any governmental method in municipal affairs. Another remarkable thing about it is that no city of which I have knowledge that has adopted it by charter, has ever receded from it. I believe there were few small cities that repealed ordinances for city managers, or partial city manager forms, but those were for reasons other than that the system was not a good one. A number of cities of very small populations felt that they could not afford to have a person salaried high enough to take over the duties.

Manager Form Fundamentally Sound

The reason, to my mind, that this is proving a good system of government, is because it is fundamentally sound. It is builded upon the same principle that our form of national government is builded,

and our state governments, and that is the separation of the legislative and executive functions of the government. Our municipal governments, outside of the manager form of government, have always been an intermixture of the legislative and executive powers. Our forefathers, in adopting the constitution of the United States, and our different states, in adopting the several state constitutions, have been far-sighted enough to provide that the three distinct functions of government, the legislative, the executive and the judicial, should be kept separate. The fault in our municipal affairs of the past does not lie with individuals, except to a minor extent. Individual frailty is not the reason that our municipal governments have been declared by experts to be the worst form of government in existence. It has been because the principle of our municipal government has been wrong. All signs point to the fact that the municipalities of the United States are coming, and will rapidly come, to the point where there will be an elimination of the mixture of legislative and executive duties in municipal affairs. Not until then, in my belief, will we have the kind of municipal government in the United States that we ought to have. There is no one who would think of electing legislators and sending them to the State Capitol to enact laws for the state, and then having them take over certain functions of the executive branch of the government, divide it up among them, and operate along the lines and under the laws that they themselves have sponsored. It would be unthinkable to do such a thing, and yet this is what we have been doing in the municipalities, practicaly in all the life time of the United States. But to my mind, it is simply an attempt to apply a principle of government that cannot be applied sucessfully, and that has made the United States the laughing stock of the world as to the conduct of her municipal affairs.

There are problems in the matter of a city manager form of government that have not yet been worked out. It may be that there will need to be changes in the methods that now exist. But the general principle must be adhered to, if we are to continue to advance in municipal government in the United States.

In Sacramento, our charter specifically separates the legislative from the executive branch. The Council is a legislative body, and it is prohibited by the provisions of the charter from interfering in any way, directly or indirectly, with any appointments of the city manager, or any operations of the departments under the city manager.

Civil Service Under Manager Government

In the matter of civil service, it has frequently been stated in print and in public address that the city manager form of government and civil service are absolutely antagonistic to each other, and that the city manager form of government could not exist unless civil service was eliminated. I don't believe that. There are different kinds of civil service. A proper kind of civil service can operate and be of immense value under the manager form of government, as well as it can under any form of government. I believe that civil service as a method of qualifying people for positions and employment is a necessity under the city manager form of government., and a necessity for proper administration under any form of government. Neither the city manager nor any one else appointing should be in a position where he could absolutely personally control all of his appointments; not his appointees, mind you, but his appointments. I believe that he should, for his own benefit, as well as for the benefit of the public and the administration, be compelled to go to a qualified list to appoint. But I do not believe that the city manager, or any other executive, can properly carry on the duties of his office, unless he has the right under proper restrictions, to remove his appointees. I do not believe that any appointing power should have the right to arbitrarily remove an appointee. But I believe that he, in some public way, should be the only one to determine whether or not an appointee should remain under his administration. If the city manager, or any other appointing power, is qualified to hold his office, he must be qualified to give substantial justice to any one who is appointed by him or working under him. If he is compelled, in retiring any one from the service, to go to a board and submit to their decision as to whether or not that appointee shall be retired, it places him in an impossible position to get proper results from appointees when they are not retired. And if an appointee is given certain rights, which I believe he should have, and which he has under some forms of civil service, he will be protected as far as he should be protected in his employment.

Now, there are two methods of civil service. One is founded upon the belief

that the person serving should be protected in his employment against his employer. The other is founded upon the belief that public service should be standardized and protected. It is not generally known, but under our state civil service, the appointing power may appoint only from a qualified list, and may remove and determine for himself whether or not the appointee shall be removed. But he must make that determination a matter of public record. A public hearing must be had if it is called for by the appointee that is to be removed. That seems to me to give any appointee sufficient protection against an improper removal. If the appointing power is willing, in a public hearing, to take up the matter of the removal of an appointee and make it a matter of record, it is a sufficient safeguard against his being improperly removed. Any public official who appoints should have the privilege and right to remove in that manner, and I do not believe you can get efficient management under any form of government without that. I have been accused on several occasions of being against civil service. I am a member of the State Civil Service Commission, and I believe in civil service. But I do not believe civil service is made just to keep people in office.

City Manager Not an Autocrat

The charge of autocratic power has been made against the city manager form of government. In answer to that, I wish to say that this same charge can be made just as truly against any official who is in any government service as an executive, under any form of government. I fail to see how any executive, under any manager form of municipal government of which I have knowledge, can be autocratic. He may be unpopular, he may be neglectful, he may be inefficient, but certainly under the city manager form of government a city manager cannot be autocratic, because he has not legislative powers.

A city manager operates under the ordinances and the laws governing his municipality, and simply carries out, or attempts to carry out, those laws. An autocrat is one who can arbitrarily inflict legislation upon a community or upon a state, or upon a nation, and enforce it without recourse. But the city manager is to a large extent an automaton in carrying out those policies, those restrictions, and those activities that are set before him. The complaint that the city manager may become autocratic falls also, it seems to me, because the city manager, more, I believe than any other kind of city executive, comes in direct contact with many citizens. The entire responsibility of the operation of the municipality governmentally, after the council has acted, is directed to the city manager. He is the target of every individual in the community. And any one who is subjected to that would not attempt to be autocratic, nor could attempt it, even if he had autocratic powers, because he is under constant surveillance by the community. The charge that a city manager form of government may become autocratic, is simply one of those charges that is raised against any new thing that may be presented for the approval of the people.

The Personal Equation

The personal equation in the city manager form of government cuts quite a figure. As I said a while ago, every individual in the city knows that the city manager is responsible if something is not done. He does not go to a commissioner and have that commissioner tell him that some other commissioner is responsible, and in that way go the round of the commissioners, and then be told finally that the commission as a body is responsible. If something is not done, if his street is not fixed, if his street is is not swept, if something is not taken care of that should be taken care of in the municipality, the offended person goes to just one man in the municipal government, and that is the city manager. He knows that the city manager is responsible; that he cannot evade his responsibility. In that lies the virtue of the city manager form of government—responsibility for the proper conduct of affairs, the proper expenditure of the moneys appropriated for municipal purposes, rests continually upon him. All individuals or groups of individuals in the community who ask for something and are given it in the budget, know what should be done and where and when it should be done, and they can go to the one individual and find out why it is not done, and why the money was not expended, as it should have been expended.

The Budget

That leads me, lastly, to the matter of the budget. I would not be willing to be city manager of Sacramento or any other city, if I did not have a budget provision in the charter. The city cannot properly operate and properly function without a budget.

When I came into office, there had been a budget prepared, not under the provisions of the charter, and in going back over the operations under that budget, it is almost impossible to find where they had followed the budget, except where their salaries were fixed. For the year previous to the time when we came in, there had been $15,000, I believe it was, allocated to permanent street improvement, and we could not find that more than about a thousand dollars had been expended for permanent street improvement out of the fund in that year. And there were other things of like nature. Where you haven't a budget there is switching and maneuvering. We prepared a budget last July, that is, July of 1921, for the City of Sacramento under the charter. That budget is being followed during the present fiscal year which started the first of last January. I would not say that the new budget, which was prepared without very much previous experience in municipal affairs in Sacramento, was anywhere near perfect. It was not. There are lots of things about that budget that were improved upon this year. Under the charter we have a provision which gives the council the right to transfer from one department to another. No money can be transferred from the fund of the department to which it is appropriated without an ordinance passed by the city council. We have operated under our budget provision up to this point, at least, this year, without transferring any money from one department to another.

I thoroughly believe that a budget must be adopted in order to get proper results in any municipal government; that it must be known to the public what the budget contains. Those who prepare the budget are constantly upon their mettle, not only properly to prepare the budget, but properly to follow it. The people are entitled to know what their money is going to be expended for, except in matters of emergency that come up after the making of the budget; they are entitled to know whether or not their streets are going to be improved, and their water mains taken care of, and so on, down the line. And if money is not needed in a particular budget item, they are entitled to know that. If the money is to be used otherwise they are entitled to knowledge through legislation by the council, so that there can be no question of the proper use of the money; so there can be no question that a department is not deprived of something that it should not have been deprived of, and that the money is being expended for a purpose that is necessary. Under a proper budget system, that can be accomplished, and the funds of the people of the city better safeguarded, and expended under a better balanced method than in any other way.

PLANT AND METHODS USED IN BUILDING MILE CONCRETE ROAD PER WEEK

Mile-a-week concrete road building has been made a reality by the Aaby-Maturi Company of Chisholm, Minnesota, paving on a section of the Miller Trunk Highway betwen the Mesaba Range and Duluth.

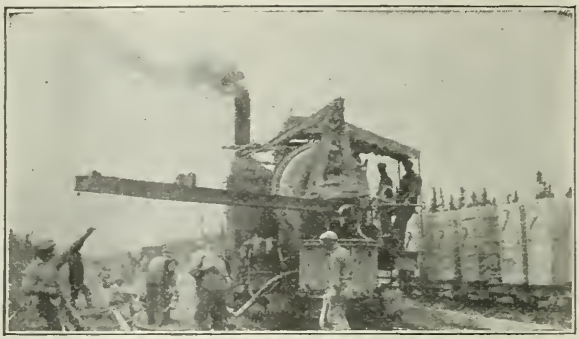
The Aaby-Maturi Company has been building concrete roads in Minnesota for a number of years. The construction recently completed included 15.1 miles of road beginning at Martins' Siding and extending towards the Mesaba Range. Although these contractors were also awarded the contract for the construction at the same time of a section from Eveleth to Central Lakes; the sections were some distance apart with the result that it was necessary to lay out two complete plants differing only in details.

Construction began on May 8th and was completed September 2, 1922. During this period many performance records were made and they are the more remarkable considering that the mixer was of the usual 21 cu. ft. size and not one of the larger sizes. Throughout the construction period a weekly average of 5,125 ft. per week was attained. The daily average over this extended period (a season's work) was 855 ft. The highest daily run was the paving of 1,260.6 ft. of road. On twelve different days 1,000 ft. or more were constructed.

Frank Aaby and Raymond Maturi, partners in the Construction Company, personally supervised the work. R. W. Acton, Chief Engineer of St. Louis County, was the engineer in charge and under him were Peter Huntington, Chief Inspector of Miller Trunk Highway, and four men in direct contact with the engineering and inspection work.

A gravel pit where raw material was washed and screened to provide the necessary sand and pebbles, was located in the middle of the work. At this ideal location of the aggregate, a central proportioning plant was built. Cement was received on sidings at Alborn and Mar-

tins, and during the laying of the road from the far end to the center it was transported by the industrial railway to the central proportioning plant. After the construction work reached the proportioning plant, the cement was stored in a house on the subgrade which was before mentioned, was placed at the gravel pit in the center of the contract. The gravel was excavated by steam shovel and loaded into small bottom-dump cars which were hauled by cable to the foot of the screening and washing plant where the contents were dumped



SMITH 21-E PAVER WHICH LAID A MILE OF CONCRETE ROAD EVERY WEEK ON AABY-MATURI CONTRACT BETWEEN MESABA RANGE AND DULUTH, MINN.

moved twice a week. The paver was charged from batch boxes brought up on cars by locomotives on the industrial haulage system. With the establishment of the central proportioning plant at one point, the expense of moving the plant was eliminated and it was only necessary to move the industrial haulage system.

Concrete Slab Specifications

The slab was constructed according to the 1922 specifications of the state of Minnesota. The pavement is 18 feet wide, and raised by bucket elevator to the top of the plant. Oversize stone was returned to the pit. Sand and coarse aggregate was moved by cars on trestles and belt conveyors and dumped onto stock piles over separate charging tunnels. The sand tanks, revolving screens, elevators and washing equipment were of the Telsmith type and were furnished by the Smith Engineering Works. Ample capacity was provided in the plant and at times as much as 12,000 yds. of coarse

CENTRAL PROPORTIONING PLANT AT GRAVEL PIT SHOWING CHARGING TUNNEL AND CEMENT SHED, AABY-MATURI CONTRACT.

7½ in. thick, with steel rod reinforcement. The mix is 1-2-4; that is, 1 part of portland cement, 2 parts of fine aggregate and 3 parts of coarse aggregate.

Batch Box Loading Plant

The loading or proportioning plant, as aggregate was available in the stock piles.

The batch box cars were spotted under the hoppers in the sand and gravel loading tunnels and the boxes filled from improvised batchers. Cement was also added at this point or later in the job

from a shed placed on the subgrade. With aggregate supplies at hand locally, no dependence was placed on railroad transportation except forcement and the railroad strike failed to affect the progress on the work.

To accomplish the remarkable progress made in the construction of this pavement, it was necessary that the paver be mixing material practically continuously. In order to accomplish this it was necessary that sufficient material be available not only in the stock piles but in batch boxes at the paver. American batch boxes holding 37 cu. feet, of material were used with 8 cars to a train. Another factor almost as important as having the materials available was the pertrial rail laid on wood ties was used, the road shoulder serving as roadbed.

The concrete was mixed and placed on the sub-grade by a 21-E Smith Paver, manufactured by the T. L. Smith Company, of Milwaukee, using a 5 bag batch of 1-2-4 proportions. The mixer traveled under its own power on full length traction. Concrete was placed on the sub-grade by means of a boom and big cross-dump bucket distributing device. The coordination of the various operations of the paver was given credit by the contractors for much of their succes in laying a mile of pavement a week.

Water for mixing the concrete and also for sprinkling the completed pavement during the curing process was pumped

TEAM SCRAPERS ON COARSE GRADING AND ROLLER WITH SUBGRADER COMPLETING FINE GRADING ON SUBGRADE, ON AABY-MATURI CONTRACT.

fect coordination between the batch box derrick and the loading skip of the Smith Paver used on the work.

When the loading skip was raised the batch box which had just been emptied into the skip was lowered back onto the car and the hoisting bale hooked to the next box. With the lowering of the skip the batch box which was counterweighted with it was raised clear of the car and the bail bearing derrick boom swung over the skip to put the box in position for emptying. These automatic functions required no attention from the paver operator.

Material Haulage

Koppel cars with two 37 cu. ft. boxes to each car were drawn to the mixer, 8 in a train, by 5 Plymouth 7-ton locomotives. A pusher locomotive was also used on heavy grades. Light weight industrial rail laid on wood ties was used, the road shoulder serving as roadbed.

an average distance of 2½ miles from the St. Louis and Cloquet Rivers.

Finishing

The fresh concrete after being laid in a ribbon on the subgrade by the bucket traveling along the boom of the mixer was further spread by men with shovels and rakes. A machine finisher then struck off to proper level and tamped the wet concrete, and by means of an oscillating belt gave the concrete the final surface finish.

Curing was accomplished by covering the newly laid concrete with earth. The earth was then sprinkled daily and served to hold the moisture to the surface of the concrete.

Workers' Quarters

Nearly 120 men were required to handle the proportioning plant, haulage system,

grading, paving, finishing and curing. Some of the crew came from nearby towns while others coming from greater distances had to be accommodated in a company camp. The camp buildings were erected at the gravel pit and proportioning plant. A portable camp for the paver crew was mounted on skids on the subgrade and moved several times each week. The men were charged only enough board to pay actual expensees.

The Aaby-Maturi Company in this piece of work have convincingly illustrated what it is possible to accomplish in road-building efficiency through a careful study of conditions, careful planning and organization, and the selection of standard equipment.

THE ECONOMIC VALUE OF HIGHWAY TRANSPORT FRANCHISES

By Arthur H. Blanchard, President National Highway Traffic Association and Professor Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

What is a highway transport franchise? Although the phrase "Highway Transport Franchise" has not been officially defined, it may be explained, as used in this paper, in order that the discussion of this topic may be intelligently comprehended. A state highway transport franchise constitutes an agreement between a state controlling body, as the party of the first part, and the highway transport operator, as the party of the second part, covering a guarantee of definite service on a prescribed route under stipulated conditions by the highway transport operator and a guarantee by the state that there shall not be unwarranted, ruinous competition by other highway transport operators.

Highway transport operators operating under franchises are motor vehicle common carriers, as they carry indiscriminately, within reasonable limitations, all persons or commodities, under general conditions of agreement applicable to the whole public, on defined routes according to definite service schedules.

Highway Transport Services Subject to Franchise Control

For example, it is evident that the highway transport services rendered in accordance with the following definitions may be covered and controlled by highway transport franchises:

Rural Motor Express pertains to the highway transportation of commodities on defined routes according to service schedules from several producers in a rural district to a terminal with or without return loads being carried from the terminal to the producers or other consumers.

Intercity Motor Express pertains to the transportation of commodities on defined routes between municipalities according to service schedules with or without service being rendered at intermediate points.

On the other hand, it is believed that the following defined services cannot efficiently or legally be covered by franchises:

Long and Short Rural Haulage includes all highway transport methods which utilize highways outside of municipalities except intercity haulage and highway transport operating on defined routes according to service schedules.

Intercity Haulage pertains to highway transportation of commodities between municipalities except highway transport operating on defined routes according to service schedules.

The same conclusions apply to the commercial transportation of persons.

The legal right of the state to control the operations of common carriers is generally admitted except in the case of interstate common carriers. At the present time, at least 22 states provide in their statutes for some degree of state control over motor vehicle common carriers.

Are highway transport franchises an economic and public necessity? To those familiar with the development of the commercial transportation of commodities and passengers by motor vehicles during the past 15 years in the United States and the longer history of highway transport in Great Britain, the answer is unreservedly in the affirmative.

Highway Transport Failures

Failures of highway transport enterprises are occurring every day due to a lack of knowledge of the fundamentals of the economics, science and art of highway transport. It is reported that 90 per cent of all highway transport companies doing business with New York City as a center fail within three years after entering this field. While 50 per cent may fail due to cut-throat competition by fly-by-night companies, it is conservatively estimated that at least 50 per cent fail because of lack of knowledge of the A B C's of efficient highway transport business methods, cost accounting, management, and the operation and maintenance of equipment. Those interested in the eff-

cient development of highway transport in the United States have a big task before them in bringing to the attention of groups of business men or capitalists, operators and prospective operators of highway transport, the necessity of having connected with their operating organizations men who are thoroughly trained in the methods of highway transport, the interrelationship of highway, railway and waterway transport, highway transport legislation, the fundamentals of highway transport cost and record systems and the principles of highway transport management, together, of course, with a knowledge of the mechanism, operation and maintenance of motor trucks, tractors and trailers.

Protecting Responsible Operators

As an integral part of the essential transportation system of America, it is absolutely necessary that highway transport be placed upon a sound business basis in order that responsible operators may be protected and that this branch of common carrier service may be conducted in such a manner as will guarantee to the public constant, efficient, economic service.

From the standpoint of public safety, the state must insist that our motor vehicle common carriers transporting passengers provide a maximum degree of safety to the traveling public and eliminate reckless driving by inexperienced chauffers and the utilization of wholly inadequate motor vehicle equipment which may be characterized in some cases as a piece of junk carrying a packing box in which persons are jammed, the resulting contrivance being called a motor bus.

State Regulatory Powers

Based on an analysis of all state statutes covering the control of motor vehicle operation, the powers given to state public service controlling bodies may be classified as follows:*

1. Grant, refuse to grant, amend or revoke Certificates of Public Convenience and Necessity.
2. Prescribe routes.
3. Fix schedules.
4. Determine character of service and promote the comfort and safety of traveling public.
5. Establish fares and rates.
6. Require reports and uniform methods of accounting.
7. Examine accounts and records.
8. Supervise fiscal affairs such as incorporation, capitalization of stock, etc.
9. Compel additions to, extensions of or betterments in physical equipment.

Qualifications of Regulating Board Members

If the powers enumerated are given to a state controlling body, what should be the qualifications of the members of such a body? It is evident that a grave responsibility to the public and to highway transport business will rest upon them. They should be men possessing vision, judicial minds, and a broad knowledge of transportation, and should be unprejudiced pertaining to the relative development of railway, waterway and highway transport. Different fields of public and business affairs should be represented. An efficient controlling body might be made up of the Attorney General of the State as an ex-officio member; a highway transport man of high standing and possessing a broad knowledge of the development of all phases of transportation of commodities and passengers by motor vehicles; an experienced highway engineer, who understands the fundamentals of highway transport and who thoroughly comprehends the relationship existing between the economic operation of highway transport and such highway factors as grades, alignments, widths, drainage, foundations, the character and maintenance of roadway surfaces, and the methods of controlling and directing the operation of traffic on highways; a business man who has dealt with big commercial problems; and a banker who is familiar with the practice of bonding common carriers and other enterprises in connection with the operation of which the public must be protected. To this group of five might be added a steam railroad man and an electric railway man provided that they possess a broad vision relative to the development of transportation in America, such as is possessed by W. H. Lyford. His comprehensive knowledge of the transportation problems of the United States was shown to the public through the medium of his admirable address before the Second National Conference on Highway Engineering and Highway Transport Education in Washington in October, 1922, during which he vividly outlined the many fields of railway transportation in connection with which highway transport may be efficiently employed and how the improvement of highways and the development of highway transport is of direct benefit to the rail-

*Report by Motor Vehicle Conference Committee, March 1, 1922.

roads. At least 90 per cent of the railway officials of the United States could profitably digest Mr. Lyford's conclusions with the result that many would be converted and in the future would not exhibit that narrow-mindedness which has led many to protest vigorously against the use of railroad taxes for highway improvement, and the development of highway transport.

In conclusion, it may be said that, in the opinion of the writer, the highway transport operator of sound financial standing, who is endeavoring to render to the public an efficient, economical and safe transportation service, will welcome the passage of state laws relative to highway transport franchises provided that they are based and administered on the principles which have been herein outlined.

The foregoing paper was presented before the Joint Session of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association at Grand Rapids, Mich., Nov. 2, 1922.

RELAYING 23-YEAR OLD BRICK IN NEW PAVEMENT AT LYNCHBURG, VA.

By Boyd A. Bennett, City Manager of Charlottesville, Va., formerly Commissioner of Public Works, Lynchburg, Va.

Lynchburg, Virginia, in the summer of 1922 made good use of the salvage value of the old, though slightly worn brick, in the reconstruction of a 23-year-old brick pavement that was approaching the limit of its usefulness. By so doing we have today a brick pavement that should give good service for the next 30 to 50 years unless there is a radical change in amount and character of residential street traffic.

By turning over the 23-year-old brick and relaying them on a more substantial foundation we have a smooth, durable pavement, and that too at a cost much less than that of a new pavement.

Lynchburg has been laying brick pavements since 1892. Two 30-year-old streets are still in good condition today and rendering satisfactory service. Another 27 years old is entitled to the same classification.

Madison Avenue is the street on which we decided rejuvenation of the pavement was necessary. In 1899 the brick were laid on the natural soil of a gravelly clay character which had been given a thin cushion of clean sand. Sand filler was used. Cost of construction was $1.20 a square yard.

The brick in the original pavement were miscellaneously assorted. The engineer at that time demanded an unusually high quality of brick, measured by standards of that day. It was impossible for the manufacturer to meet the requirements fully, so that finally the quality standards were reduced after the job was partially completed, and the manufacturer put up a bond guaranteeing the quality of his material.

In spite of these considerations no maintenance was required for 23 years except that incident to replacing cuts and openings. Modern traffic conditions brought about the necessity of improving the alignment of the surface which had become rough due to lack of substantial support of the wearing surface.

FIG. 1—VIEW OF 23-YEAR-OLD BRICK PAVEMENT IN LYNCHBURG, VA., PRIOR TO RECONSTRUCTION.

A selection from three possible methods was open to Lynchburg in improving the condition of Madison Avenue:

1. Build a new pavement.
2. Use the old brick pavement as a base, for some bituminous wearing surface.
3. Use the brick themselves in a reconstructed pavement.

We carefully weighed the possibilities of each of the three methods, holding the first named as a last resort. We studied the experience of other communities in respect to the other methods named, but from the standpoint of first cost, as well as later maintenance costs and durability. Our studies, both at home and abroad, convinced us that no proposition had in it the elements of economy offered in the continued use of the brick already in the wearing surface on Madison Avenue. While collectively the brick were out of order, individually they had a high salvage percentage.

FIG. 2—STREET NARROWED, BRICK CLEANED AND RELAID READY FOR ASPHALT FILLER.

At the request of property owners it was decided to cut down the width of the street from 46 to 27 ft. between curbs. Upon removing the brick a careful examination showed them to be in good condition.

The design determined upon provided for a 4-in. concrete base, sand-cement bed, use of the old brick, and asphalt filler.

Fig. 1 shows the street before new construction was started. A slight unevenness can be noticed in spots, also some of the brick are cobbled.

Fig. 2 shows the concrete base complete and the brick relaid prior to application of the filler. This picture reveals the good condition of the brick and the smoothness of the surface.

In removing the old brick we used common labor. The brick were torn up with crowbars and conveyed to the side of the road on roller conveyors, the conveyors cutting the cost of handling and also serving to help clean the brick.

The excavation was done by teams, plows and labor, using trucks for transportation. The excess dirt was hauled from one-half mile to one mile.

Slag was used for the coarse aggregate in the concrete base ranging in size from ⅝-in. to 2¾-in. The mix was 1-3-5.

The cost of cleaning the brick was more than expected, as no efficient method was used. Men were employed using old currycombs and wire brushes. A total of 5,060 sq. yds. of brick were removed and because of narrowing the street only 3,545 sq. yds. were relaid. The excess yardage will be laid on another street. We did not credit this paving with the salvage of old brick.

The asphalt filler used had a penetration of 40 to 50.

Old stone curbing was reset and new stone radius curbs were set. All new radius curb set had not less than 10 ft. radius as compared with 2 ft. radius in the old curb.

It was necessary to do a little sewer work, such as making connections to the new catch basins and lowering some house connections. Cost of this is found in the expense statement.

Fig. 3 shows the pavement as com-

TABLE I—COST OF RELAYING OLD PAVING BRICK AT LYNCHBURG, VA.

	Material Used	Cost	Unit Price
Removing Old Brick	5,060 sq. yds. (1,050 cu. yds.)	$320.34	.0633
Excavation	Paving Excavation	1,518.90	1.448
	Park Grading	744.60	
Concrete Base	3,545 sq. yds. (394 cu. yds.)	3,681.24	9.353
Cost of Relaying Brick	3,545 sq. yds.	1,229.00	.347
Cleaning Old Brick	5,060 sq. yds.	756.72	.149
Resetting Old Stone Curb	2,177 lin. ft.	512.03	.235
Asphalt Filler	3,545 sq. yds.	711.79	.2008
New Curb Radius	336 lin. ft.	354.30	1.053
		$9,828.92	1.053
Engineering and Inspection		246.13	
General Expense (Includes Equipment; etc)		461.01	
Catch Basins and Sewers		171.76	
		$10,707.82	
Actual cost per sq. yd.		$3.02	

pleted. The new sidewalks are not included in the paving cost as this work in our city is handled under a separate petition. The cost of grading the parkways between the curb and sidewalk is given in our total cost. This item also includes the cost of seeding.

This is a residential street. Traffic should not increase greatly over what it is at present. If this proves to be the case, this street should give good service for the next 30 to 50 years, and that, too, with but very little maintenance.

In Table I is given the actual cost of the work.

FIG. 3—STREET COMPLETED BY APPLICATION OF ASPHALT FILLER.

TRAFFIC MARKING PAINT

Two tests of the Traffic Marking white paint manufactured by E. I. du Pont de Nemours & Co., have just been completed. One of the tests was made by the Pennsylvania State Highway Department, where the white traffic paint was laid on two separate locations—one on the brick road leading from Harrisburg to Carlisle at the western approach of the Susquehanna River Bridge and the other on Route No. 1, just above Rockville. The test proved that it kept its color on oil surface roads in better fashion than any paint hitherto used. Another test was made by the Massachusetts State Highway Commission, and a favorable report was made by that body also on the durability of the paint. There is a constant demand for white traffic paint from municipalities and highway bodies for the purpose of marking out zones along streets and highways. This demand has become so large that there is at least one firm specializing in this kind of paint.

FINANCING A STATE HIGHWAY SYSTEM

By Roy D. Chapin, President Hudson Motor Car Co., Detroit, Mich.

We can be assured that the premises upon which we are laying the foundation for vast highway systems are intrinsically sound. This need is not a temporary one and we are justified in large expenditures so long as we can be assured that the policies which we lay down for the control of those expenditures are wisely shaped.

The task which confronts us, then, is one that requires the wisdom of the statesman, the vision of the social economist, the acumen of the financier and the efficiency of the engineer.

At the outset it places a heavy burden upon all responsible authorities, with a sure compensation ahead for those who proceed with the needs of all in mind, and with just as sure a reaction against those who give heed to special as opposed to the general welfare.

Manufacturing Problem Presented

In any analysis which I have made of the subject of highway finance, I have been impressed with the fact that what we are concerning ourselves with is fundamentally a business proposal. After all we are not dealing merely with the building of roads. We are dealing instead with the production of transportation, which is just as much of a manufacturing process as is the building of the motor vehicle itself.

Accordingly, the business analogy presents itself as a sound rule for highway policies, since in its adoption we return to principles which have been tested and found practical over a long period of years.

The first item then is to analyze the need. This we have done. Next we must determine just what roads are essential to earn the income which shall justify our expenditure, how rapidly these roads shall be built, which ones shall take precedence.

Analysis of Financial Resources

Knowing these factors which can be surely determined by careful and accurate surveys, not alone of traffic but of economic possibilities, we must then proceed to analyze our financial resources, determine our possible income and then proceed to select that type of administration which will build our highways most carefully and most economically, with due regard for the purposes for which they are intended.

Policies Will Vary

The first question, then, which confronts us is a determination of the present stage of development of this manufacturing plant which we are taking over. If it is a going concern, with ample facilities in the shape of already improved highways, then we will probably find that we can draw sufficient revenue to meet our requirements from current operating income. We may need a short term bond issue here or there, to take care of a special extension such as a widened road or improvement from an inferior to a superior type of pavement, but in the main we can pay-as-we-go.

Of all of the states in the Union, Maryland is perhaps the best example of this kind which we have and one of the very few, since Maryland has already improved most of its main system through long term bonds and is now concerned chiefly with the maintenance of these highways to meet the traffic requirements.

If we are discussing a state such as Michigan, however, we find a somewhat different situation, A fifty million dollar state bond issue, coupled with county and federal funds, will complete all of the state system except the 400 miles added by the last legislature. That completion, however, does not include improvements of a number of gravel roads which must be raised to a higher type because of increased business or traffic and, consequently, the situation may present the need for new manufacturing facilities or roads which may require a supplementary bond issue, the extent of which will depend upon the actual growth of traffic in the interim.

Virginia Example of New Territory

Then we turn to a state such as Virginia, only now upon the threshold of a venture in the production of transportation. Here the plant is in such shape that if we hope to care for the business which is awaiting us now, we must immediately turn to a bond issue as the means of raising the initial capital outlay, as otherwise the drain on our current income would be so great that while we might be able to construct our roads, we could not maintain them. And it is just as absurd to build roads and not maintain them as it would be to build a factory and then allow it to go to pieces.

Beyond that, however, we have accepted theories in business finance which apply definitely to the case at hand. No large

business organization today, or few small ones, will attempt to finance capital expenditure out of current income. The reasons are obvious. If, for example, a manufacturer should say "I need a new factory. It will cost me $50,000 and will produce 10,000 tires." He could not then say, "I will distribute that cost $5.00 per tire over my next year's output." Business competition would not permit such practice, but he could distribute that cost over a period equivalent to the length of life of the factory, and then assess each consumer accordingly.

What Is the Life of Highway?

The question which then arises is, "what is the life of this factory?" You will hear men say that our roads are going to pieces and that the analogy between business and engineering practice breaks down at this point.

If this question arose in a business plant, the executive would call in his research men and put the question to them. Suppose we call upon the research men of the U. S. Bureau of Public Roads, or, taking a short cut, turn directly to the report of the chief of the bureau, T. H. MacDonald?

"Much that we have known about highways is not so" we read, and summarizing an official viewpoint, we find that a close survey made by the Bureau shows that 40 per cent of all of the Federal Aid projects costs has gone into permanent features of the highway such as location, drainage, gradients, curvatures, shoulders and engineering costs. Of the remaining 60 percent, allotted to surface costs, we find that when the time for reconstruction of the highway comes all but a percentage equivalent to the cost of interest and sinking fund is salvaged as bedding for the new surface.

In a word, we find that we have been led into the fallacious belief that to lose the surface has been to lose all.

Lack of Maintenance Funds Costly

But this is not all. The executive searchings for still further supporting data finds that in many cases the actual reason for surface deterioration has been a lack of adequate maintenance, an overloading of equipment in times of seasonal strain. Expert opinion tells him that the engineer can build the road to handle the traffic and that all that is required is absolute maintenance.

The judgment then is that we are justified in distributing our capital costs, provided we require maintenance, and we can proceed knowing that what we are doing is to provide as expeditiously as possible a network of highways which we shall have the use of in our lifetime and which we shall pass on to our children for their use, in turn, each generation paying a fair rental charge in the form of maintenance costs plus amortization costs.

Will it cost us more to follow this plan than to pay the charge from current operating expense? Yes. Are we justified? Yes. how? By these two facts, either of which is sufficient. First, we are supplying a universal human need—adequate transportation for all. Second, the increased use of the highways by the public in our own lifetime will more than offset the amortization charges, even if we could deny the increased valuations which will accrue to urban and rural properties, which we cannot. Moreover, if we built from current funds, we should have an average of only 50 per cent of the use of a given mileage in, say, a 10-year program, while by paying as we use, we shall have practically a 100 per cent usage. Yet the difference in cost is only found in the amortization charge.

Rigorous Limitations Necessary

We shall not make these statements, however, without imposing certain rigorous limitations. One, that of maintenance funds, has been mentioned and it cannot be stressed too emphatically.

Further, state bond issues should not be sought for roads of purely local use. Generally speaking, these will carry only a light traffic and maintenance costs will suffice. State issues should be concentrated on those highways which traffic and economic surveys show are of first importance from the state point of view. If this system is carefully laid out, it will be found that there are few points more than 15 miles from a main road and the policy of financing these feeders will depend upon the character and extent of the traffic.

Again, the administration is an important element. The leaders must be men of vision who will deal with this problem as with any major issue of public welfare. Control should be centralized in their hands as the local man cannot be expected to, nor should he, consider state needs first. Any departure from such a program as this is likely to result in disconnected highways and the question of maintenance becomes a highly uncertain equation.

Traffic Regulation Paramount Issue

The question of traffic regulation is an-

other where only the state official can act with due regard for the economic needs of the community. We have indicated that overloading of the plant has been a partial cause for its breakdown in the past. Power should be lodged with the state authority so that he can prohibit overloading the vehicle in normal times and can make such restrictions as to loads as will safeguard the general welfare at seasonal periods.

By the same act, the commissioner should have power to permit overloading in emergency. The only purpose for road construction is to serve traffic and situations such as the present railroad congestion may make it cheaper at times to break down an inadequate highway surface than to permit unemployment, hunger or cold to come to a community.

This brings us logically to a discussion of what kinds of highways we shall construct. The answer is found solely in economics. That type of highway should be constructed which will care not only for the present but for the future needs of traffic. No highway improvement is justified if it does not satisfy a human need or unless the cost of improvement is more than cared for in the saving effected to the public through better and cheaper service. The problem is so large, the needs so many and diversified, that over-development is just as serious an economic error as undevelopment.

Construction and Maintenance Defined

How are we going to pay for this improvement? In a general way we have said that original construction is a matter of capital outlay; so also is any extension or any replacement of an inferior type of pavement to the extent of the difference in cost. The analogy is that of a new factory building or the replacement of old machinery by improved units.

Maintenance then becomes all of the remaining charges or in effect the constant making of needed repairs up to and including reconstruction, in order that the plant may give service at all times.

At this point we are faced squarely by the need for saying from what sources we are to draw our income in order that our finances shall be equitably levied so that the public may buy its transportation at the lowest possible cost.

Answer Varies With Locality

The answer will vary in detail according to the stage of development of the system or plant with which we are dealing. It will vary according to population, square miles of area, mileage of roads under consideration. But still we have before us definite principles based upon studies of fact which well may be taken as sign posts.

It is a safe principle to say that those who benefit from the highway shall pay for its construction and maintenance. Who is it that benefits? Definite economic surveys made by the Bureau of Public Roads show that in the initial improvement of the highway there is found an accretion in the value of land in the vicinity which ranges anywhere from 300 to 1,000 per cent. More important, there is the fulfillment of a human need which, while it may not be directly susceptible to economic treatment, is none the less a large factor in road construction, particularly in the agricultural regions.

Urban Valuations Increased

Urban valuations are also increased by the construction of rural highways, because not only does the highway bring new buying power to the city but it also brings about a tremendous suburban development which is, as yet, only in its infancy.

Finally, the man who uses the highway finds his costs lessened as it is improved, or better, as it is maintained in a constant condition of service.

Taken in sum, these three elements represent all of the tax-paying elements of the community; hence it may be fairly said that capital charges for highway construction should be provided for from general taxation whether these payments are made in the form of amortization charges for a long term bond issue, which spreads the charge over this and succeeding generations of beneficiaries, or whether it be a special levy.

When we come to the question of maintenance, however, the problem is not as clear, as we have not had sufficient research to determine accurately all of the secondary influences of improvements upon valuations.

We do know, however, that the user of the highway is one who obtains the first service from it, that his costs are affected as the highway is kept in condition or allowed to go to pieces, and finally, that much of its depreciation is due to use.

Provides Annual Revenue

It thus appears that the user should be charged with the upkeep of the road, a principle which is sound from a financial standpoint in that our present system of motor registration is a recurrent annual charge which automatically produces the revenue necessary to maintenance. For

this reason, it is fair to insist that motor fees should be set aside for maintenance rather than diverted into construction, and further, it is reasonable to demand that the administration of these funds shall be so controlled as to make the highway of the utmost service.

In conclusion, then, I should say that we cannot solve the highway finances of a country so diversified as this by any detailed formula, but we can proceed to adopt certain definite principles which mty be expressed somewhat in this way.

Principles Suggested for Adoption

1. Highway systems should be laid out by state highway departments, with a definite view to meet the social and economic needs of the commonwealth.

2. The funds needed for original construction should be secured from long term bond issues and the money needed to amortize these bonds should be provided for from general taxation. The funds needed for maintenance should be secured from current operating income derived from the user and should be adequate to maintain the highway once constructed.

3. Centralized administrative control is essential to a proper development of these systems as well as to the regulation of their use, and broad powers should be granted the state department in charge, to insure an economic flow of traffic.

It is hardly necessary to emphasize, in closing that the need for general bond issues will be dependent upon the degree of present improvement of the system.

The problem which confronts us is one of satisfying a proven human need, the elemental desire for individual transportation, the fulfillment of which is a social as well as an economic necessity to our further progress.

The more rapidly our finances can be placed upon such a basis as this the more rapidly will the states, as a whole, afford new opportunity for free communication which should be the right of all.

The foregoing is from an address by Mr. Chapin before the recent annual meeting of the Michigan State Good Roads Association at Grand Rapids.

FEDERAL COURT UPHOLDS VALIDITY OF WARREN PAVEMENT PATENT

Immense costs of litigation plus hundreds of thousands of dollars in royalties —in all a bill which may exceed $300,000 —is what will have to be stood by the state highway fund of Oregon as a result of years of demagogic agitation against paying anything for the right to use patented paving, says the Oregon Voter for Oct. 7, 1922. The article continues as follows:

In Oregon we have a State Highway Commission which in quality of personnel is of the highest rank, the foremost men of the state in personal integrity and demonstrated business success are and have been the members—and this highway commission contracted for miles and miles of patented paving, giving it the preference at an equal price in competition with unpatented pavements of supposedly equal quality. The agitation was carried to the point of attempting to destroy the character of individual commissioners. There seemed to be no limit to the hysteria of defamation.

Year after year the legislature refused, by ever-decreasing majorities, to enact legislation against patent paving. But as men of courage were retired on this issue, and demagogues elected to replace them, it was only a matter of time before the majority would be the other way. This came about three years ago, shortly before the paving patent expired, and legislation was enacted directing the attorney general and the state highway commission to use the type of paving regardless of the patent and fight the patent in court in order to avoid payment of royalty. With this legislative direction, there was nothing for the highway commission to do if it desired to use this superior type of paving but to use it and fight the patent.

In this way the issue was brought into the federal court.

In defiance of this patent right, the state contracted for about 1,200,000 yards of the patented type of paving, and entered into contract with the contractors to protect them from infringement suit. This was according to the legislature's intsruction.

Prior to that time, millions of yards of this same type of patented paving had been contracted for by the highway commission on a competitive basis—type against type, with price considered in proportion to quality. The matter of royalty did not enter into the award—that was fixed after open bidding on a competitive basis. It was a matter of common knowledge that the competition was so keen that the amount of royalty fig-

ured in the price was only 10 cents a yard.

But with defiance of the patent and use of it regardless of its proven standing in court, the patentee was in a position to sue for his full royalty of 25 cents a square yard—which on 1,200,000 square yards amounts to $300,000. The test suit was brought against one contractor only, and covered only 75,000 yards. Judgment for the full 25 cents a yard was awarded by the federal district court, the opinion being handed down by Federal Judge Robert S. Bean.

This opinion shows that the opposition to the patent through all these years had not a leg to stand on. Everybody who had studied the facts knew that this was the case, but the agitation was kept up regardless of the facts. No decision could be more sweeping in its denial that there was any real justification for having brought the case into court at all.

This decision, except for the appeal with its inevitable result, is the end to an agitation which has torn the state for years,—except that the bill must be paid to the tune of several hundred thousands of dollars which otherwise might have been expended for much-needed road construction. It is an end that was inevitable from the start. At no time was there any real ground for the agitation, for the courts had sustained the patent time and again. The unfortunate thing about it, aside from the reputations wrecked by demagogic newspapers and the wasteful acts of incompetent officials, is that the final huge cost must be paid out of the highway fund instead of from the property of those who prospered by a wicked agitation.

The decision by Judge Bean is brief. Its full text follows:

Full Text of Opinion

"I have at great labor carefully examined the elaborate record and briefs in this case and am satisfied the plaintiff is entitled to the relief demanded.

"The patent in suit was issued in May, 1903. The pavement therein described has been extensively laid throughout the United States and proven a commercial success. The validity of the patent has been contested in practically every state in the Union and with few if any exceptions has been upheld. It was held valid by the Court of Appeals of the Sixth Circuit after a strenuous contest. Judge Lurton writing the opinion in Warren Brothers vs. City of Owosso (166 Fed. 309), the Court of Appeals of the Second Circuit in Warren Brothers vs. New York (187 Fed. 835), and by the District Courts of Alabama (Warren Brothers vs. Montgomery, 172 Fed. 414), Michigan (Warren Brothers vs. Grand Rapids, 21 Fed. 364), Pennsylvania (Warren Brothers vs. Evans, 234 Fed. 657), Ohio (Warren Brothers vs. Pace, 247 Fed. 117), and New York (Warren Brothers vs. New York, 187 Fed. 832). Injunctions have been issued in many courts restraining the infringement of the patent and in only two or three instances, so far as I am advised, been denied and then for reasons not affecting the merits.

"The patent was recognized as valid by the defendant and by the State Highway Commission, the real party in interest, and many miles of pavement laid under license from the patentee upon which royalty was paid prior to the legislative act of 1919, providing that if in the opinion of the Attorney General an alleged patent is invalid or of doubtful validity the State Highway Commission may, if it deems such patented material to be advantageous in the construction of a highway, use or contract for the use of same and indemnify and hold harmles any contractor as a result of such use. The question of the validity of the patent, in pursuance of this law, referred to the Attorney General who reported that without further litigation he could not advise whether it was valid or not. The Highway Commission therefore contracted with the defendant for the laying of certain pavement and stipulated that it would indemnify and save him harmless against the use of a patented article, and hence this suit.

"The decision of courts other than the Court of Appeals of this circuit are, of course, not binding on this court, but they are strongly persuasive and when, as here, there is such a mass of decisions uniformly upholding the validity of a patent, judicial comity suggests that a trial court should not assume to declare them erroneous or hold the patent invalid unless for some defenses not before considered, sustained by clear and satisfactory proof. As said by Judge Dickenson in the Evans case, supra, referring to the patent now in suit:

" 'Independently of the merits of the question of the validity of a patent, there must come a time when that question must be deemed to have been settled, whether rightly or wrongly, nevertheless settled. If this be not so, rights evidenced by letters patent are no rights at all. All which can profitably be said

upon the subject of the validity of this patent is embraced in the opinions accompanying rulings already made. * * * Such validity is supported by the prima facie findings of the patent office. It has confirmation in a juridicial experience so extensive that a mere list of the cases in which it has been litigated would unduly lengthen this opinion. This experience has embraced adjudications, not only in a number of the District Courts but in the Circiut Courts of Appeals in two different circuits and recognition in three other circuits supplemented by consideration in almost, if not quite a round dozen of applications for preliminary injunctions. Out of all of this judicial consideration, something in the nature of the establishment or denial of some definite rights must have resulted. What we find has resulted in the establishment of the validity of claims 5, 6, 9 and 11 of this patent beyond the reach of successful attack upon any grounds then litigated.'

"The defenses made in this case of anticipation by prior uses, prior patents and literature and double patenting are the same as those involved in prior litigation either in fact or in kind. The evidence here does not show anything substantially new in respect thereto, or any reasons why the conclusions of such courts should not be followed.

"The pavement of McGovern Alley in Denver, principally relied upon, and the Pittsburg pavement, were held by Judge Dickenson in the Evans case, supra, not to anticipate the Warrens' patent. Washington pavement, in all substantial respects the same as the one urged here, was rejected as anticipation in the Montgomery and New York cases. There is nothing, as far as I can see, in the evidence concerning South Omaha and Hamilton pavement to anticipate or invalidate the plaintiff's patent. The alleged prior patents and literature contain nothing new in kind from what was before the courts in the other litigation. The defense of double patenting is the same as was urged in the Owosso and New York cases. All these matters have been carefully considered by able courts, after protracted and painstaking litigation and nothing could profitably be added to the discussion.

"The defense of non-infringement is not made out. The pavements laid by the defendant under his contract with the State Highway Commission and involved in this suit are in all particulars the same as that previously laid by him and the Highway Commission upon which royalties were paid and in my opinion are clearly infringements of plantiffs' patent.

"There is no dispute as to the yardage, 74,541.8 yards, and the evidence shows beyond question that 25 cents a yard is a reasonable royalty.

"Decree may be prepared accordingly."

LIGHTS FOR MOTOR AND HORSE DRAWN VEHICLES AND HIGHWAYS

By David Beecroft, Directing Editor, The Class Journal Co., 239 W. 39th St., New York, N. Y.

Highway accidents always serve as a spur to new regulations and laws governing the operation of motor vehicles, and whenever accidents increase there is generally an increased activity among the drafters of bills in the field of motor legislation.

Unfortunately there has not been as broad a study of the causes of accidents, or even the classification of accidents in the different states, as there should have been, and those drafting new bills are generally without that knowledge of the cause of accidents which should serve as a good guide in drafting remedies that will function effectively. Too frequently measures have been passed to avoid accidents which have been drafted without any knowledge of the causes of accidents which give rise to the legislation, with the result that the new laws have not been the answer to the question.

We are having accidents with motor cars, motor trucks, pedestrians, motorcyclists, horse vehicles, and, in short, all classes of vehicles. There is no general agreement among state officials as to the cause of these accidents.

In Michigan, Chas. J. DeLand, Secretary of State, says that accidents are occurring continually on the highways of the state due to improper equipment of both motor truck and passenger cars. Secretary DeLand goes on to state that no other law on the statute books of Michigan is more openly violated than that regulating lights on motor vehicles of all descriptions. The Hon. Secretary makes no reference to lights on horse drawn vehicles, or the absence of them. That is a factor in the category of accidents. However, he continues: "Trucks are being operated on the highways with a searchlight on the cab which is like a blinding headlight to persons approaching in the opposite direction and these

same trucks very often have a big trailer with no light of any description on the rear, to say nothing of the width of the body. My suggestion is some drastic legislation that will compel owners and drivers of trucks to equip same with two white lights on front that can be turned on the road and with a red or green light on each side of the truck on the rear." So much for the views from Michigan.

New York state has a different report. Bert Lord, the Director of Motor Vehicle Bureau of the state of New York says:

"I have no information on file as to accidents. However, I am aware that there have been a number of accidents due to wide truck bodies and on account of it a bill was introduced requiring a green light on the outer left-hand corner of the truck so that motorists could know the width of the truck body when approaching. The measure did not become a law and I do not think I would approve the green light. However, a white light possibly would be good."

I am glad to see Mr. Lord opposed to green lights for reasons to be given later.

The state of Maryland has a system of highways used a great deal by motor trucks, but D. Marshall Shroeder, Deputy Commissioner of Motor Vehicles, cannot recall any accidents due to the width of motor trucks. His office does not classify accidents or collisions between different types of motor vehicles.

Mr. Shroeder continues: "I do believe that it is an excellent plan to suggest that all motor vehicles carry a light similar to a parking light on the extreme left, showing white in front and red to the rear."

The State Commissioner of Connecticut has gone further than officias in any other state in a study of accidents and for two years has investigated every accident occurring on the highways of the state and has classified these accidents, showing the number in which the blame is due to motor cars, motor trucks, motorcycles, trolley cars, horse vehicles, railroads, pedestrians, etc. This analysis for 1921 shows that approximately 91 per cent of all accidents on the highways can be eliminated by highway improvements, better highway lighting, improved signals, better lighting of motor vehicles, improved regulation of all vehicles and general education of those using the highway. The Commissioner of Motor Vehicles believes that only 7 per cent of all highway accidents cannot be avoided. Because of the study that has been given to this subject in Connecticut, we should hear carefully what the Commissioner of Motor Vehicles has to say. He exhibits that commendable qualification of meekness, admitting that the more he has studied the subject, the less is he willing to attempt to settle the entire question by regulating lights on different classes of vehicles:

"I need to be convinced that accidents happen on account of the absence of some light which will indicate the character of the vehicle and while I have not our statistics on this point yet,—offhand, I am doubtful as to whether they will bear out the suggestion that has been made to the effect that lack of lights indicating truck width is a fruitful cause of accidents. These words from Robbins D. Stoeckel, Commissioner of Motor Vehicles for the state of Connecticut, are deserving of careful consideration, as this state is crossed by the highways between New York City and Boston; in fact, by the highways between New York City and the greater part of New England. These highways have heavy motor truck traffic; perhaps heavier than any other state in the Union.

In the commonwealth of Massachusetts the green light on the extreme left side of the truck is favored. It is considered a convenience as well as a factor of safety.

Pennsylvania has no record of any special accidents caused by motorists not being familiar with the widths of motor trucks.

Minnesota has had very few accidents due to the width of trucks and has no regulations calling for lights to indicate truck width, but Secretary of State Mike Holm adds:

"We have had very few accidents due to truck width." Time will not permit further comment on the experience of the different states but in no others can evidence be secured that width of truck has been a special factor in accidents.

After reading the opinions of motor vehicle commissioners in half a dozen states that now have heavy motor truck travel, only one conclusion can be reached, viz: that perhaps with the single exception of Connecticut, no adequate analysis of accidents has been made to establish any relationship between lighting of vehicles and the accidents.

Perhaps up to the present we represent the concensus of opinion by stating that motor cars are too often overlighted and motor trucks generally underlighted. We

rarely meet the motor truck with its dazzling headlight, but too frequently we meet the inefficient pair of oil lights on the truck that are not adequate and are in reality useless except as signal lights.

Let us now briefly consider the highways on which these vehicles operate day and night. Some of these roadways have become virtually high roads for commodity and passenger transport, similar to our railroad lines. They have outgrown quite entirely the use made of them a few years ago, yet notwithstanding this transition, they are not lighted in any sense commensurate with the travel on them. Perhaps the road surface has been improved, but more equipment is needed along these high roads of commerce than merely a surface.

Why should we not take a chapter from railroad transportation, trolley transportation and marine transportation and equip these highways as the traffic over them demands? In other words, after building a permanent surface roadway, complete the job by getting it ready for use, not merely in daylight hours, but during as many hours of the night as the need of the times demands. Again, may we repeat: Let us finish the job.

A railroad is not completed when the roadbed is done and the steel rails laid. The signals for day and night travel are as essential as the steel rails. Our riverways and canals are not completed when the adequate depth of channel is achieved; the signals for day and lights for night must be installed. What an intricate signal system has been developed along our coast for coastwise and high sea travel! What a system of lights and signals has had to be established for the air service between London and Paris, as well as other air routes!

In this rather extended reference to railroad, marine and aerial lighting along their respective ways of travel, there has been no thought of diverting attention for adequate lights on all users of our roads, but rather the thought has been to survey broadly all factors entering into safety on our highways and not to be guilty of approaching the subject from a single and selfish viewpoint.

Elimination of accidents will not be achieved by attacking at one point but rather by correlated attacks at all points where attention is needed. Connecticut has shown that where an accident a day occurred on a part of the highway, further accidents were practically eliminated by relocating a short portion of the highway and removing bordering interferences. The old location was safe for horse traffic and for years was fairly safe for motor traffic, but with the present multiplication of traffic, the only solution of accidents lay in relocating the offending section of the highway.

Our cities have done excellent work by improved traffic control, by establishing safety zones for pedestrians, by an attempted control of pedestrians, by surface markings on streets, by suitable night signals, etc. This commendable work prompts us to ask the question if our State Departments, having control of our highways, have realized sufficiently that some of this work needed in making our cities and towns safe, should be extended to the rural highways, particularly those portions constituting main arteries with heavy travel all day and part of the night.

Highway Lighting

Before leaving this aspect of the highway, let us consider briefly the subject of highway lighting. It is only in the last few years that this subject has been given anything resembling serious consideration by concerns that have developed systems for city lighting. The A B C of highway lighting has yet to be written. A few stretches of highway are being lighted with experimental systems that give promise of excellent results and our state departments must keep this subject in mind as a part of the problem of making our highways safe and a part of the task of highway regulation.

The last year has witnessed rapid development in the use of signal lights at street interesections in suburban areas. No uniformity exists in the color or location of these lights. In one city of 40,000 population in the zone of Greater New York are three different colored lights on a leading highway in the distance of two miles. All three are blinking types of intermittent lights, one showing a green light in both directions; another green in one direction and white in another; and another red in one direction and green in another. There is no field for intermittent lights of this character on the highway because of the tax they impose on the mental energy of the driver. A steady green light is preferable and safer. In a night trip of 20 miles north from New York City and in other directions as well, the driver is confronted with a veritable chaos of lighting schemes, each of which demands a mental problem at a time when the driver is

approaching a danger zone and when most of his mental alertness is needed in watching other users of the highway and controlling his vehicle. All highway signal lights of this character should be standardized not only as to color, but as to height and location.

Lights on Vehicle

Coming to the consideration of the lights to be carried by all vehicles using the highway, I aim to be sanely conservative by emphasizing that the time has arrived when vehicles of all character must be equipped with a lighting system, standardized so far as color and position of lights are concerned. We cannot temporize longer with the horse vehicle without lights—that is a double danger—first to itself and second to the other users of the highway. We cannot temporize further with the motor truck that hangs a lantern with a red glass from the center of the body at the rear. We cannot temporize further with the traction engine pulling a threshing machine and water wagon with not a rear signal light and too frequently a single lantern with white glass on the front.

Our highways at night are no longer used for a few miles by residents along the route, but nightly are interstate roadways used by vehicles whose owners may reside in the adjoining state or several states beyond. Nightly these highways are used by those who are often strangers to them, not infrequently by many who may not use them again for years. This character of travel makes it correspondingly more important that all users observe the lighting laws. In writing regulations governing lights, there must be no favoritism for any particular type of vehicle, all must be considered as users of the highway and equally subject to regulations governing their use.

Considering the specific lights used perhaps no one light has been more widely discussed during the past year than that of the color of the tail light. About one year ago a movement was started, backed partly by railroad interests, to have the use of the red tail light on motor vehicles discontinued and a yellow light substituted. The reasons advanced were that where roadways paralleled railroad lines, locomotive engineers were at times confused in their signals. Fortunately, we feel certain there has been a change of heart and now the railroads are resigned to the use of the red tail light on motor vehicles and everybody else from scientists down, are of the opinion that there exists no better rear signal than the red light. Its future use is undoubtedly assured. It should be the universal light for the rear of all highway vehicles, motor propelled, horse-drawn or propelled by persons. Such a standardization of its use will simplify night driving, will conserve the mental energy of the operators of all types of vehicles and should be conducive to better physical control of vehicles, with a corresponding lowering of accidents.

Granting that the red tail light is to be the permanent light, its location is yet open to debate and also the candlepower of the light adequately to illumine the state registration numerals. The commonwealth of Massachusetts has recently attacked this problem with vigor and the new law requires the lamp portion to be above the middle of the license bracket and to throw a white light over the face of the numerals. This light must be thrown through a glass portion of the lamp and not through mica or celluloid window. No objection can be urged against what Massachusetts has done. It is merely carrying out the intent of the original law in many states covering the illumination of lighting bracket. This new law is a just one.

The location of the tail light is far from being a settled question, particularly on motor trucks, threshing machines, trailers, etc.; the extreme left rear of the body is considered generally the most useful location in that it designates the extreme edge of the body and so serves as a guide to overtaking vehicles that must pass on the left. This location should avoid those accidents due to no indication of the body width when the light is under the center of the chassis. A red light at the extreme left should be carried on all types of horse vehicles, motor vehicles, trailers and machinery in tow, such as threshing machines, etc.

There is no necessity for two red lights on the rear of any vehicle. It has been suggested that on large trucks there should be a light at each side of the body at the rear. Some states go so far as to suggest a red light at one side and a green light at the other. Two lights merely double the number the drivers in following vehicles have to see. They will confuse rather than clarify.

Our lighting of vehicles and roadways must be simplified to the final syllable and it is the first rule of vehicular lighting not to use two lights where the job can be done better with one. This may

be opposed to the business adage of making two blades of grass grow where one grew formerly, but the case is different. Let the rule be to let one suffice if it does the job. Further, there should be no necessity for specially large tail lights on motor trucks, a standard size will suffice, if properly located, and with an adequate candlepower of illumination.

Still another thought with regard to the tail light. If it is to be placed on the extreme left rear of the body, it can play the dual role of showing a red light to the rear and a white light ahead, thus indicating the approaching vehicle, the extreme width of the vehicle body.

This brings us to the question of the use of a light showing forward that will indicate to approaching vehicles that the vehicle is a motor truck as well as indicating the extreme left side of the vehicle. You will recall that the use of such a light is much disputed by the motor vehicle commissioners in different states. The author of this paper is open-minded as to the use of such a light, but has definite opinions concerning its color. Only a white light should be used. A green light has been suggested, but it will add to the confusion of drivers of approaching vehicles, particularly at the present time when green lights are used on highways for so many other purposes. We repeat: "Good lighting on vehicles should be simplified rather than be made more intricate."

The alphabet of color is red for danger stop.

White stands for forward illumination and signals. These are enough for the vehicle.

The universal alphabet of green is for caution and its use should be confined to the role of highway signals. The green light might be used to advantage to indicate highway obstructions, detours, roadway forks, islands or zones of safety, dangerous highway intersections and other highway markings.

The foregoing paper was presented at the recent joint meeting at Grand Rapids, Mich., of the National Highway Traffic Association and the Michigan State Good Roads Association.

HOW LONG SHOULD WATER WORKS BONDS RUN?

The proper term for which water works bonds should run was the subject of a paper recently presented before the New England Water Works Association by Charles W. Sherman of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass. The paper will doubtless be published in full in the Journal of the Association. Mr. Sherman's conclusions are as follows:

1. The average life for a "typical" water works plant in this country is about 50 years. It will rarely be less than this in individual cases, and may be as much as 60 years or more for some works.

2. Complete records of depreciation, including abandoned structures, of a number of water works plants of considerable age show that the total accrued depreciation of the physical plant of such works is about 20 per cent of the cost. Departures from this mean are not great. Records of depreciation suffered by the plant still in service, modified by a suitable allowance for plant abandoned, confirm this as a reasonable normal figure.

3. The corresponding average age for works of 50 years' life is 20 years, leaving 30 years average remaining life. If the average useful life were 60 years instead of 50, the average age would be 27 years and the remaining life 33 years. Thirty years is a fair estimate of the average remaining life of any water works plant in normal condition, and therefore a proper term for which water works bonds should run.

4. If the works have suffered a depreciation of 20%, including abandoned property, there is a residual value of 80% of cost of the physical plant. Water works bonds may therefore safely be issued up to 80% of the normal cost of the works.

5. Municipally owned water works should be self-supporting and their financing should be on the same general basis as that of private corporations.

6. The clause of the present Massachusetts law which limits bonds for the extension of municipally owned water works to a term of 5 years is illogical and burdensome, and should be repealed.

7. Special legislation for particular cases, made necessary by the existence of the 5-year limit, is undesirable from every point of view.

8. Suitable control over municipal bonds for water works purposes can be exercised by requiring the approval of the Public Utilities Commissioners in exactly the same way as for bonds of a private water company.

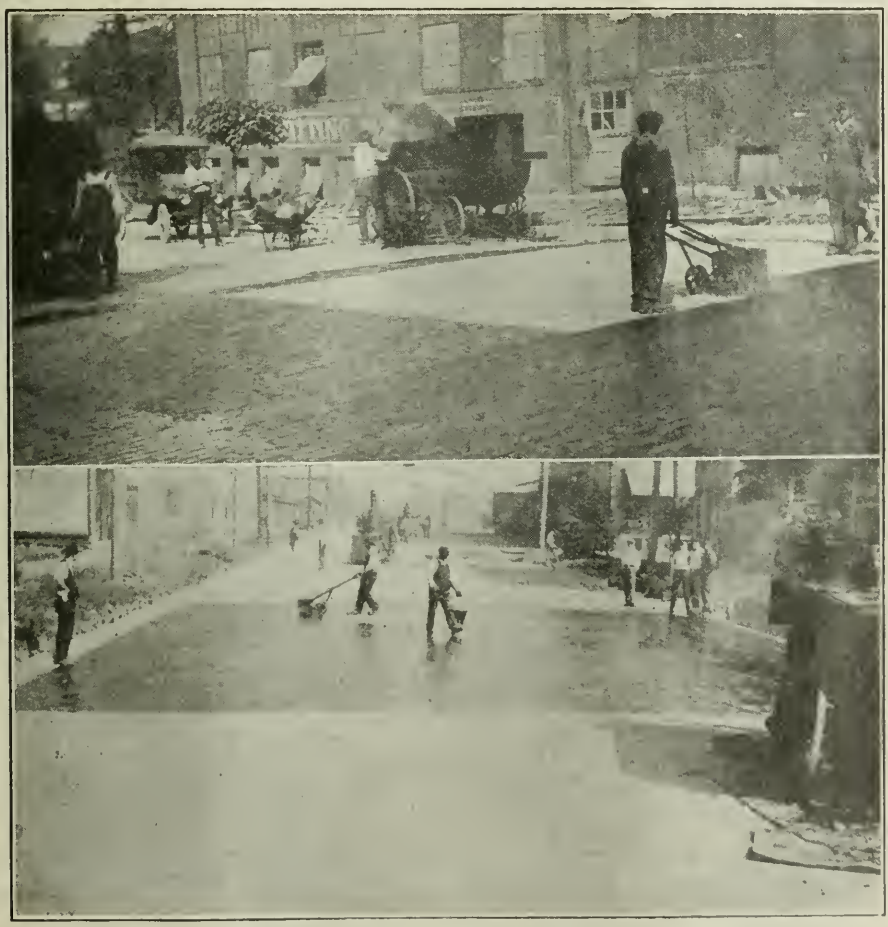
9. Misuse of water revenues can be avoided by legislation limiting their uses to water works purposes.

EFFICIENCY IN THE APPLICATION OF ASPHALT FILLER

By J. F. Gallagher, Asphalt Sales Department, The Texas Co., 10 South La Salle St., Chicago, Ill.

Contrary to an all too common opinion, the proper application of asphalt filler to brick pavements is somewhat of an art, as definite and distinct as the mixing of concrete for the foundation, or the placing of the brick themselves. The main thought in the minds of many individuals as regards the application of the filler is to cover the greatest yardage in the shortest possible time. They almost lose sight of the fact that the function of the filler, as its name implies, is to fill the interstices between the bricks and to leave a relatively thin carpet coat on the surface. A moment's thought will bring out the principal factors incident to this end, and while some of the features mentioned below may seem to be so obvious and elementary to some as to render them unworthy of space in these columns, experience and observation seem to indicate that it is these simple considerations which are frequently overlooked in practice.

For instance, we frequently see the unfilled brick being rolled and re-rolled on the fresh sand cushion, with the result that an appreciable amount of sand is forced upward into the spaces between the bricks. In many cases the sand will more than half fill the joints, so that it is physically impossible thoroughly to fill them with asphalt. As is generally recommended by those whose experience qualifies them to speak with authority, before any asphalt is poured the brick

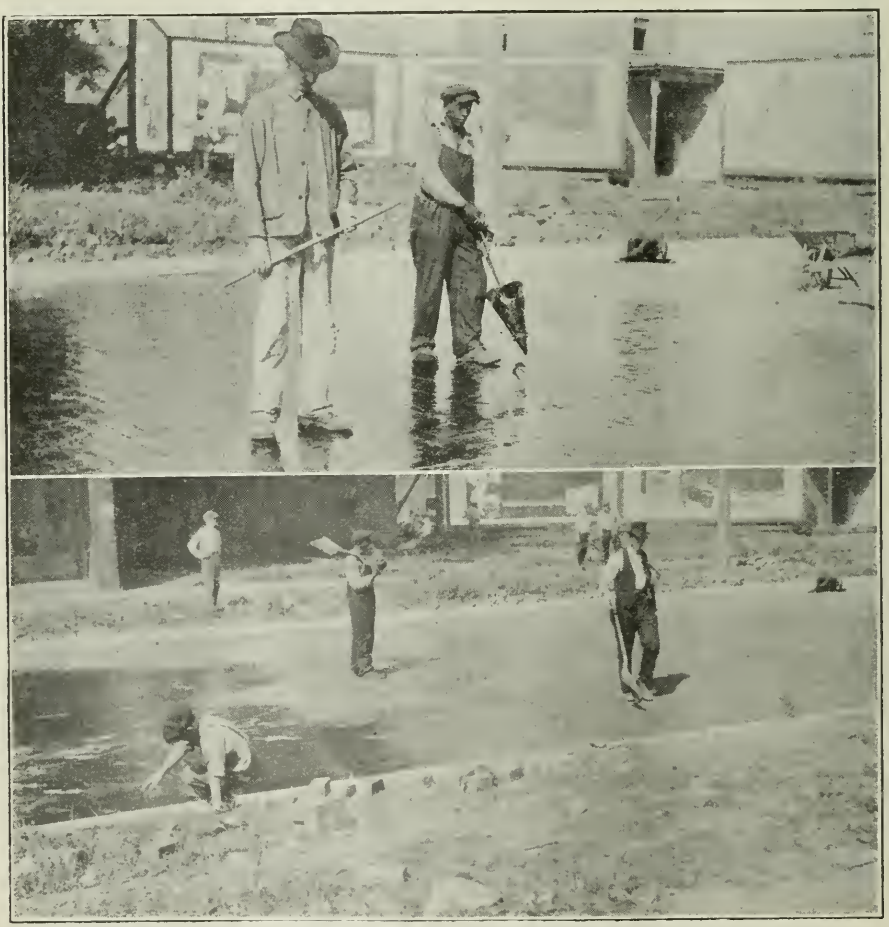


APPLYING ASPHALT FILLER ON BRICK PAVEMENT AT DECATUR, ILL.

Upper: First Application of Texaco No. 39 Paving Filler by Squeegee Cart Method. Lower: Another View of the Application of the Filler by the Cart Method. Completed Pavement in Foreground.

should be swept carefully to remove any sand or foreign matter which might affect the bond between the asphalt and the brick surface, as even a thin film of sand or dust will seriously hinder the adhesion of the hot asphalt to the brick. Also, in order to effect thorough adhesion, the brick should be dry, as any dampness will result in a foaming of the hot asphalt when it comes in contact with the moisture, due to the latter being converted into steam. In this way the asphalt is chilled before it has had an opportunity to bond with the brick and probably will be quickly worn away by traffic.

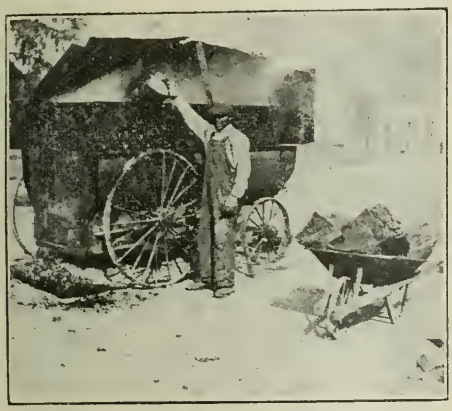
Another feature frequently given too little consideration is the preparation of the asphalt for applying. It is most desirable to cut the material into chunks as small as practicable. This will materially shorten the time required to bring the contents of the melting kettle to the desired fluidity, due to the greater surface area exposed to the heat. It is infinitely better to spend a little more time in cutting the asphalt into small pieces than to put a few large chunks into a kettle and try to rush the melting of it by increasing the intensity of the fire beneath it. Too much stress cannot be placed on the fact that the most approved method of melting is by a slow uniform heat and frequent stirring. Incidentally, there are many cases where no means of stirring is provided on the job. An old mortar hoe can be used for this purpose conveniently. However, regardless of the instrument, the molten asphalt should be stirred regularly to prevent charring, and as the material most liable to be affected is that in the bottom of the



APPLYING ASPHALT FILLER ON BRICK PAVEMENT AT DECATUR, ILL.
Upper: "Pointing Up" After Final Application of Texaco No. 39 Paving Filler. Note Uniform Surface. Lower: Applying Covering Material.

kettle directly over the fire box some means should be provided for keeping it in motion.

The maximum safe working temperture for material such as is generally regarded as standard for brick pavements is about 375 deg. F. If the heat exceeds this point constant and thorough agitation must be introduced to avoid breaking down the adhesive qualities of the filler. For general purposes a satisfactory working range is from 300 to 350 deg. F. depending upon weather conditions and the characteristics of the particular material. In order to control the temperature it is strongly recommended that melting kettles be provided with satisfactory thermometers which may be suspended in the asphalt at all times during heating. There are several types of extra large armored thermometers on the market especially adapted for this purpose and of such design that the reading can be made



CHARGING MELTING KETTLE WITH CHUNKS OF TEXACO NO. 39 PAVING FILLER.

from a considerable distance from the kettle. They are so constructed that they can be suspended in the material and be temporarily removed while the kettle is being charged.

Practice of An Illinois Contractor

In the face of such widespread disregard of the fundamental principles leading to most satisfactory results from the use of asphalt fillers, it is indeed refreshing to witness the results obtained by an Illinois contractor specializing in work of this kind. Walter C. Schwartz with headquarters at Bloomington, Ill., has had a very broad experience in the construction of asphalt-filled brick pavements and has met with excellent results from a careful handling and application of the filler.

Having taken care of the preliminary features, such as sweeping the brick, etc., Mr. Schwartz makes the initial application of asphalt over an area of about 200 sq. yards. This partly fills the joints and leaves a thin film on the surface of the brick. After the asphalt has been given an opportunity to cool, it contracts so that the joints are only about half filled. Then follows a second application over the same area, which is intended to fill the joints flush and slightly increase the thickness of the surface coating on the brick. As applied the asphalt is flush but upon cooling it contracts and drops slightly below the general level. In order to bring this flush with the squeegee coat, a third application is made after which the pavement presents a smooth uniform appearance.

As will be found in almost any job of brick paving, there are usually a few brick the corners of which have been broken off in handling, or which may have been laid a little farther apart than the others. Of course such places require a greater amount of filler in order to eliminate the holes or relatively open joints. To take care of such spots, according to Mr. Schwartz' method, they are "pointed up" by means of the old fashioned cone-shaped pouring can.

After "pointing up" dry torpedo sand is spread in the usual way, and while hot sand is to be preferred, good results have been obtained in warm weather from the use of dry torpedo sand or stone chips free from dust.

One might gain the impression that the successful procedure as above outlined would entail the use of considerably more filler and a greater labor cost than the ordinary single-application method. However, Mr. Schwartz states that from his experience he has proved he does not use any more material than the average contractor in a single application. This he attributes to his squeegee machine method of applying the filler which enables him to go over the area much more rapidly than by the hand squeegee method. The second and third applications require very little material, and for the reason that the machine must of necessity be pulled over the pavement at a rapid rate in making these applications, the labor cost is low.

This method might be characterized as filling the joints "from the bottom up."

The accompanying views illustrate the

methods referred to as practiced by Mr. Schwartz on work at Decatur, Illinois, on which he was engaged as sub-contractor, the general contractors being File & Collins of Decatur. The asphalt used on this work was Texico No. 39 Paving Filler.

Attention might be drawn to the type of squeegee machine used, which is regarded by the contractor as being largely responsible for the success he has had in filling brick pavements. It enables the operator to apply as much or as little material as desired, the amount spread being regulated by the speed with which it is drawn over the pavement. Also due to the fact that the hot material is spread as soon as it strikes the pavement, a very uniform finish can be obtained. In this respect the writer considers it far superior to the ordinary hand squeegee, as it eliminates to a large degree the possibility of a large amount of hot material being poured over the pavement before it can be squeegeed into the joints. Where this occurs the material chills quickly, forming a relatively thick mat on the surface of the pavement, and instead of filling the joints, simply bridges them.

NEED FOR CONCERTED ACTION WITH RESPECT TO LAND DRAINAGE

By Edgar A. Rossiter, Consulting Civil Engineer, 127 N. Dearborn St., Chicago.

A number of events during the last decade emphasize the need of drastic and concerted action along the lines of National conservation and reclamation, flood control, reforestation, water power and drainage.

In the last ten years there have been a continuous series of floods on the various rivers of the country, leaving a trail of devastation in the destruction of shipping, docks, buildings, bridges and the flooding of cities and farm property, causing the loss of millions of dollars and, I dare say, that the total cost of this damage would have paid for the required flood control works.

The high price of an inferior grade of lumber and the total absence of the better grades brings to our minds the millions of acres of forest lands that have been cut with but little provision to replant these vast areas with new trees and the continuation of the policy will eliminate all the better grades of lumber and add to the cost of construction and living for generations to come, unless immediate steps are taken to reforest the cut-over lands that extend the entire length of our country.

The gradual increase in the cost of coal year after year and the mighty power displayed by the floods in our rivers should be a burning factor toward the development of water power wherever possible and the harnessing of these giants of destruction so that they may become the giants of constructive energy, thereby reserving the supply of coal.

Thousands of our best farmers are deserting and abandoning the worn-out soils of the Eastern and Central states, migrating to the fresher soils of Canada where the Canadian government has made wonderful inducements in the way of credits and farm loans while right in our midst lie millions of acres of rich soils in the lands along the creeks, rivers and lakes, that extend in an endless chain throughout the country. These lands require only proper drainage and protection from overflow to make them the garden spots of the world.

A certain amount of drainage work has been done among the higher rolling lands along the head-waters of many streams, but this work has been constructed to the detriment of the owners of undrained lands on the lower portion of the river. On these bottom lands more or less wide, the grade is small, the river is tortuous and the drainage work is most expensive and often times the cost is prohibitive. The lack of velocity or current in the river has caused bars and snags to form which hold back the flood waters until they have spent their energy by flooding the surrounding lowlands and at times the higher lands.

To obviate the flooding of these lowlands, levees have been constructed and pumping plants installed, and even these have been washed away.

These are the lands and areas that suffer from spring floods. They will continue to suffer until laws are enacted that will enable the entire watershed or catchment area to be treated as a single unit, beginning the work of reclamation at the mouth of the stream which should be dredged, straightened and cleared of snags and debris, and prepared as a waterway or barge canal as far as possible, thereby lowering the water-table which will drain the adjoining lowlands and create an outlet for the drainage of the higher lands. This work should be continued until every

individual branch has an outlet for complete drainage.

It is to remedy these conditions that the National Drainage Congress was organized to urge new legislation in order that the work might be done. Three interests enter into the benefits derived and the costs should be divided and borne by them in proportion to such benefits, namely, the national, state and county governments and the property especially benefited. Every avenue of commerce through which freight may be carried should be fostered and improved by the national government and whenever a stream may be made fit for use as a barge canal or commercial waterway, the cost of such should be borne by the government. Interstate streams, wherein the work may by reason of lowering of the watertable in the straightening of stream lines, furnish a natural waterway and drainage of adjoining property, the cost should be divided between the national, state and county governments and the property benefitted.

When you stop to consider the scope of the undertaking and the many interests involved you will readily see why no definite action has as yet been taken.

The theory of majority rule is now and has been the great factor that has held back and killed many a drainage scheme, for it must be remembered that the lowlands are in the minority, both in acreage and owners and until some scheme can be advanced to prove benefits to the higher lands, the organization of entire catchment areas into drainage districts by petition will be an impossible proposition.

The theory of benefits due to better sanitary conditions on account of drainage may be one element that may enter into consideration.

The fact that the increased value of reclaimed lowlands will add to their tax value, thereby reducing the amounts paid by the higher lands may be another element to include the higher lands.

Is it possible that we have been considering drainage of a catchment area as the only element that enters into the betterment of the entire community, and, like playing a tune on a single string of a violin, we have been unable to function, or would not obtain a better tune to play on all four strings and in our larger sphere combine all the elements that may enter into the reclamation and development of a certain area and by such a combination of elements have a legal reason to organize them into a single reclamation district?

There is another element more potent than any yet discussed that enters into this reclamation scheme that affects both the low and the high lands and the dweller thereon, and that is a potable water supply. Every community must depend on its own watershel for its water supply, and the demand for pure water may be used as a factor to prevent pollution of all streams and waters, and therefore conservation of our water supply may be accomplished as the first element, and by which the high and lowlands are equally benefitted; as the greater population live on the higher lands, yet look to the stream in the lower areas to obtain a water supply.

Inasmuch as during flood time the lowlands are flooded with the refuse of the higher land and become the breeding place of the disease-bearing mosquito, and decayed vegetation, is becomes necessary to eliminate the swamp areas that all the waters of a stream may be potable and free from the contamination, peculiar to swamp areas.

The conservation of a potable water supply may be that missing element through which all lands may be brought into the classification, "to be benefited."

A potable water supply is beginning to agitate many of our inland towns and cities as in many locations the available supply is not sufficient.

Special laws will have to be enacted in many states to enable this work to be accomplished, and I believe the possible productivity of the rich reclaimed swamp lands should be given greater weight than the worn-out soils of the higher lands. The percentage of owners and acres of land owned by the petitioners should be greatly reduced and the necessity and reasonableness of the improvement should be the questions involved and not the number of owners or acreage owned by them. In other words, you do not wait until one-third or one-half the population has contracted smallpox or yellow fever before you start to eradicate the disease, but, on the contrary, if one person is infected you jump to eliminate him, but diseased, sour, poorly drained lands, not able to pay taxes are left until one-half or one-third of the adjoining property owners consent to their reclamation.

The foregoing paper was presented by Mr. Rossiter before the recent annual meeting of the National Drainage Congress at Kansas City, Mo.

WELL DRILLING PRACTICE IN NORTH CAROLINA

By F. G. Godfroy, Superintendent Water and Light Department, New Bern, N. C.

The city of New Bern, N. C., has a series of four wells located in the center of a 70-acre tract and these wells have delivered on test over 2,500 gals. per minute, and as our normal requirements are about 1,330,000 gals. per day we have no need to worry about our supply for several years to come. We are drilling at the present time an additional series of wells to take care of the fire hazard, and when these are completed we will have a system that will take care of almost any situation that may arise.

Wells of our system located within 100-ft. of each other show but little loss of head when any one well is pumped to capacity; in one case an 8-in. well was pumped to 800 gals. per minute with a loss of head of only 24-in. in a well only 90-ft. from it.

One of the main things that a well driller should be sure of is that the bottom section of his casing is driven into the first stratum of rock that he encounters so that there will be no danger of any surface water seeping into the well. If this is not done, it makes no difference how good a supply of water one may get there is always the possibility of the supply becoming contaminated from this source. Most of the pollution in deep well supplies comes from this very cause. It is remarkable the distance that surface waters will travel through the ground and pollute a well supply.

When a suction pipe is installed inside the casing of a well care should be exercised to see that the top of the casing is properly sealed so that no dirt or rainwater can get in the well. As this part of the plant is seldom looked over it is frequently a source of trouble.

In the eastern section of this state, the drilling of wells is not a very expensive operation as we have seldom struck any very hard rock. Most of the rock encountered is a shell rock and is not very hard. We seldom encounter any granite. This enables us to drill wells at a very reasonable price, as it allows the use of a very light rig, and a great portion of the well can be washed down without any trouble until the first rock is encountered. Then we have to put in a drill to break up the rock and use a sand pump to take out the broken rock and dirt. The drill we have used with the best results in this soft rock is a home made drill a great deal like the old-time star drill long used to cut through brick walls. This is not so expensive as the regular spud and can be more easily sharpened and handled with the lighter rig as it is so much lighter than the ordinary string of drilling tools. With this tool we can generally make from 8-in. to 1-ft. at each drilling as this type of drill does not clog up and only quits cutting when the crushed rock gets deep enough so that the drill does not hit the hard rock when it drops.

Close to the surface this crushed rock is easily washed out if we have a supply of water available sufficient to overflow the casing, but at the lower depths we have to resort to the sand pump. This sand pump is made of a piece of pipe slightly smaller than the well casing with a bail on the top to fasten line, and in the other end a valve similar to the old leather valve used in the ordinary pitcher pump. The sand and rock is forced up into this pipe and then by raising and lowering the pipe the water is forced out of the top of the pipe and the sand and stone remain. This has to be raised to the surface and there dumped by hand, and this operation has to be continued until we can raise no more sand or rock and then the whole operation has to be gone over again.

We usually get the best results in washing down wells with a centrifugal pump as they are easier to handle and a pump of large capacity is not so cumbersome to carry around to the well location.

We usually dig a small surface well or sump and fill this with water from some outside source, provided we cannot get a supply by going down a few feet. The overflow is carried back to this sump and the water used over and over, so that a very small amount of water suffices for this work. We locate the sump a short distance from the well so that a ditch can be cut and the washings of rock and sand can be cleaned out of the way and the water run back into the sump.

We have not had to case any of our wells below the first stratum of rock as we have always encountered a fine grade of water bearing sand immediately we drill through the rock, that gave the wells the necessary capacity for our needs.

The foregoing matter is from a paper by Mr. Godfroy before the recent annual meeting of the North Carolina Section of the American Water Works Association.

Construction News and Equipment

IMPROVEMENT IN CENTER JOINTS FOR CONCRETE ROAD

By C. V. R. Fullenwider, M. Am. Soc. C. E., Manager Elastite Department, The Philip Carey Co., 40 Wayne Ave., Lockland, Cincinnati, Ohio.

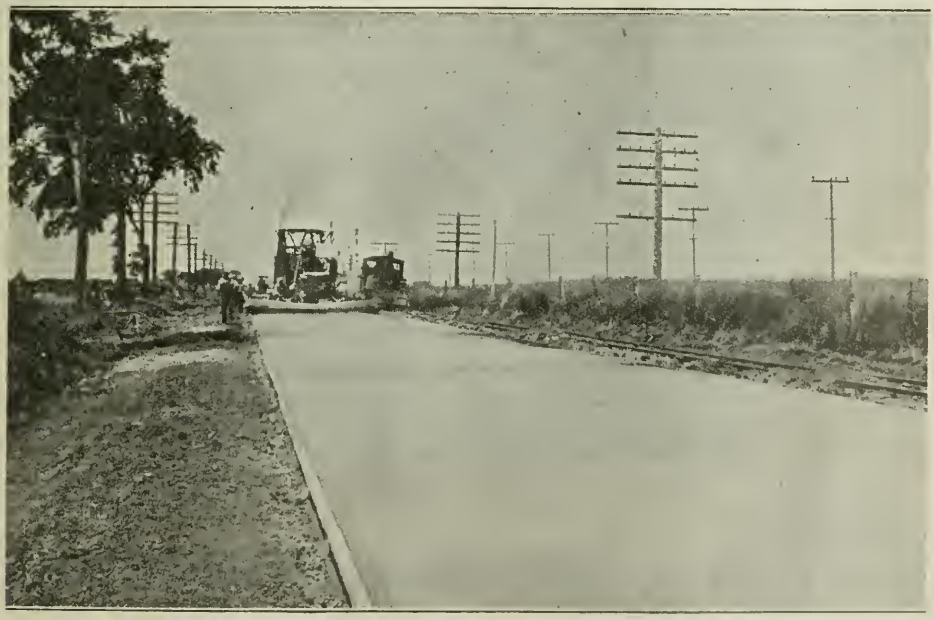
Use of a longitudinal central joint in concrete roads has become well established in many states. The principal advantages claimed for this construction are—first: the elimination of disfiguring longitudinal cracks; second: the ease with which the road may be built in two longitudinal halves, doing away with the necessity of providing and maintaining detours; third: the tendency of the joint to produce an automatic separation of the two lines of traffic. These facts have been amply verified through observation and experiment and are quite familiar to most highway engineers.

There have admittedly been several more or less serious disadvantages encountered in connection with the use of centering joints. These difficulties are being carefully studied and the underlying causes are becoming better understood. Recent developments in this direction have produced some rather startling results.

A logical approach to the matter of a better center joint naturally involves the question of what constitutes the perfect joint. United opinion on this point is doubtless as difficult to attainment as perfection itself. There is unhesitatingly submitted, therefore, the following list of properties, possession of which would in the writer's opinion enable a center line joint for concrete roads to approach very closely to the ideal:

1. It must be of such shape as to interlock adjacent concrete slabs in order to preserve uniform surface alignment.

2. It must interpose between slabs a compressible, yielding cushion. This pre-



THE FIRST INSTALLATION OF ELASTITE TONGUE AND GROOVE EXPANSION JOINT.

Illinois State Road between Dwight and Gardner. Built July, 1922, by State forces in charge of H. W. Hartman, Superintendent, and C. E. Clark, Foreman; G. O. Consoer, Resident Engineer. The portion shown had center longitudinal joint only, which was submerged ¼-in. below the finished surface.

vents the edges of slabs from crushing and spalling at the joint.

3. Material and construction must be such that joint is effectively waterproofed.

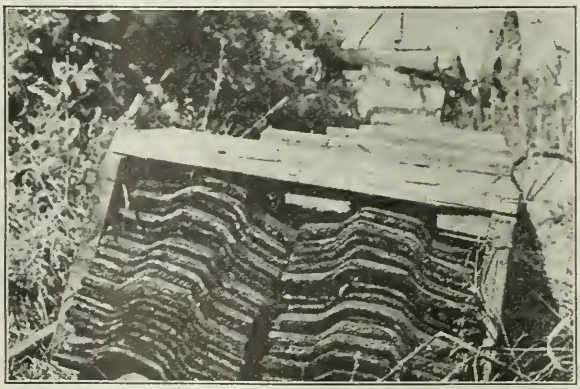
THIS SHOWS THE RIGIDITY AND STIFFNESS OF THE ELASTITE TONGUE AND GROOVE EXPANSION JOINT, EVEN WHEN CARRYING THE ⅝-IN. DIA. x 15-IN. LONG ROUND STEEL PINS. THESE PINS WERE PASSED THROUGH A JOINT AND DRIVEN INTO THE SUBGRADE TO SUPPORT THE JOINT MATERIAL IN POSITION.

4. It must be capable of simple and economical installation by common labor.

5. It must be so constructed that there exists no possibility of damage to vehicle tires, horses hoofs, or pedestrians, should any part of the joint become displaced during construction or exposed by wear of the concrete.

for center line use and recently put on the market in various thicknesses and widths. This product satisfactorily fulfills every requirement laid down in the preceding paragraphs, having the additional advantages of the felt and asphalt sandwich construction which has made the name "Elastite" famous.

Designed to interlock adjacent sections of concrete, it is fittingly called Elastite Tongue and Groove Expansion Joint. In the 1/4 in. thickness, it has sufficient body



ELASTITE TONGUE AND GROOVE EXPANSION JOINT AS RECEIVED ON THE JOB. END OF CRATE REMOVED TO SHOW HOW JOINT STRIPS NEST TOGETHER FOR SHIPMENT.

6. The life of the joint must be not less than the life of the concrete.

7. Maintenance costs must be at a minimum.

In this connection highway engineers will be much interested in the new form of Elastite Expansion Joint, developed to absorb any movements of the slabs due to settling of the subgrade or frost heaving. Edges of concrete in contact with it cannot spall or crush. Only a thin edge is exposed to traffic, avoiding any tendency toward rutting at the joint. If preferred, the joint may be concealed or submerged

below the finished surface. The tongue and groove feature prevents uneven settlement and maintains surface alignment, tending to prolong the life of the pavement and minimize maintenance expense.

READY FOR CONCRETE. TWO MEN PLACING A 10-FT. LENGTH OF ELASTITE TONGUE AND GROOVE EXPANSION JOINT; THIRD MAN INSERTING TRANSVERSE DOWEL RODS.

Installation is as simple and easy as with the ordinary types of joint. Almost any simple form of holder will do. A plank or a section of plate may be used, or the material may be supported by removable stakes. Perhaps the best method is the use of 1/4 or 3/8 in. steel pins about 15 ins. long, spaced at fairly close intervals. These may be passed through the "tongue" and driven into the subgrade, the tops being left 1 in. or so below the level of the concrete surface.

Elastite Tongue and Groove Joint has shown up so well in actual service tests that it has been officially approved and adopted as an alternate on Illinois State Roads for 1923. Installation costs have run astonishingly low as compared to other center line joints placed by the same crew of men under practically identical conditions. Other states contemplate trial installations next year. The new joint has aroused much genuine interest among those who have examined it, and its use in concrete roads is confidently expected to remove most of the objections to central longitudinal joints which have heretofore been exposed.

ELASTITE TONGUE AND GROOVE EXPANSION JOINT SET UP IN THE ROAD, SUPPORTED IN PLACE BY STEEL PINS DRIVEN INTO THE SUBGRADE, AND READY FOR CONCRETE.

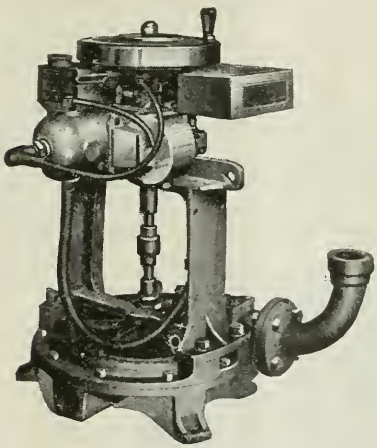
While intended primarily for use longitudinally in roads, there is no reason for limiting it to this service. Installed transversely, 1/4 to 1/2 in. thick, it should be doubly efficient, functioning not only as an expansion joint but also securely keying adjacent slabs together in a firm yet flexible and watertight grip, permanently and without deterioration.

THE EVINRUDE CENTRIFUGAL PUMP

A product which is constantly finding new and unsuspected markets for itself is the Evinrude Centrifugal Pump, made by the Evinrude Motor Co., Milwaukee, Wis.

For the past twelve years this company has manufactured the famous Evinrude Detachable Rowboat Motor of which more than 150,000 have been sold. About six years ago one of the Evinrude engineers conceived the idea of installing this same dependable 2-H. P. Evinrude gasoline engine in a small, compact centrifugal pump. After months of improving and refining the new pump was perfected and quietly placed on the market.

Because of its compactness and portability it made quite a hit with the building contractor who had an occasional need for a pump to clear the water out of



EVINRUDE CENTRIFUGAL PUMP FOR CONSTRUCTION JOB PUMPING.

his excavation after a rainfall. One day a sewer contractor saw an Evinrude at work and decided to try it out for draining his trenches. Occupying a space only 16x23-ins. and weighing only 115 lbs., this remarkable little pump could be lowered right down into the ditch and be submerged in the water. There was no need for any "installation." The Evinrude could be used with or without a suction line.

And so, one after another, new types of users for the Evinrude Centrifugal Pump have come to light. With its capacity of 5,000 gal. at a 20-ft. head and its built-in power plant it can do many kinds of jobs far more economically than larger pumps because its price and operating expenses are lower. For portability and adaptability, its makers claim it to be without a rival.

Today the Evinrude is known to more than a score of different industries. Bridge builders use it for emptying coffer dams and supplying water to the mixer or hoisting engine. Road contractors use it for pumping water in case of emergency. In quarries, gravel pits and mines the Evinrude solves one of the biggest problems—by supplying an efficient, economical means for disposing of drainage water.

Public service and street railway companies in a number of cities use the Evinrude for underground work. Because of its portability many fire departments use this handy outfit for pumping the water out of flooded basements.

Every sand dredge is equipped with a large sized Centrifugal Pump which must be primed. For this purpose an Evinrude is ideal because of its quick action and extreme compactness. Owners of scows and barges use the Evinrude for bailing out the hold.

Just recently a series of heavy rains threatened to spoil a county fair because a large portion of the fair grounds was low land. A crew of five men with large diaphragm pumps could make no headway, but an Evinrude Centrifugal Pump which was on display at the fair made short work of disposing of the excess water. The Evinrude is used by some people for watering lawns and gardens and on small irrigating jobs.

For users requiring a more powerful pump the Evinrude No. 1½ has been developed. This outfit pumps 7,400 gals. per hour at a 20-ft. head and is powered by a 3½-H. P. Evinrude Motor.

IMPROVEMENTS IN GRAMM PIONEER TRUCKS FOR 1923

Engineering and unit changes in Gramm-Pioneer trucks for 1923, by the Gramm-Bernstein Motor Truck Co., Lima, Ohio, are as follows:

Model 10, Speed Truck which has for the past 3 years proven very satisfactory when engined with a 3 1/2 x 5 motor will in future be equipped with a 3 3/4 x 5 motor which besides being built with a 5 bearing crankshaft of liberal dimensions, includes also all of the latest up-to-date post-war motor engineering and building practices, such as full force feed oiling to all bearings through drilled crankshaft, by means of gear driven oil

Start *now*—
to work for Good Roads!

IT'S none too early. Spring—the season when actual operations must begin—is just over the hill. Plan now to have the Tarvia Truck working in your community this year.

Tarvia roads are moderate in first cost and more economical to maintain than any other type of highway that will stand up under modern traffic. Their non-skid surface is smooth, dustless and mudless all the year round.

Call on our Special Service Department. The experience of skilled highway engineers—based on intimate knowledge of every type of road construction—is freely at your service.

Please address your letter to our nearest branch. It will receive prompt and careful attention.

Visit our Booth at the A. R. B. A. Road Show, Chicago, Jan. 15th to 19th

New York Chicago Philadelphia
Cincinnati Pittsburgh Detroit
Minneapolis Dallas Salt Lake City
Toledo Columbus Richmond
Denver

The Barrett Company

Boston St. Louis Cleveland
New Orleans Birmingham Kansas City
Atlanta Bangor Youngstown
Baltimore Omaha Houston

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N.S.

pump, removable head, hot spot manifold, high sight oil gauge, all moving parts enclosed, etc., together with extreme simplicity and acessibility of all parts.

Due to the universal tendency of users to overload far beyond manufacturers' ratings, the rear axle has been increased in size in such essential parts as bevel gear, pinion, differential, carrier and bearings and an additional annular has been located at the lower or bevel end of the pinion to assist in taking care of the strains of severe service.

Model 65, 1 1/2-2 ton worm drive formerly engined with continental Red Seal Model N, 3 3/4 x 5 will in future carry their new J-4 motor of same size but with all of their latest improvements of drilled crankshaft, gear driven oil pump, force feed oilings, hot spot manifold, etc.

While this model will continue to be regularly built with North East generator and distributor ignition from Exide Heavy Duty truck type battery, it will also be furnished with Eisemann High Tension Magneto Ignition, in connection with electric lights and horn, as an extra.

The emergency brake which formerly operated on rear brake drums will hereafter be of ventilated shoe type and operate on the front propeller shaft, leaving double the braking surface in rear drums available for the foot service brakes, thus insuring easier and better control, with less wear on brake linings.

Model 20, 2-2 1/2 ton worm driven: In this capacity they will replace the former Continental Red Seal C-2, 4 1/8 x 5 1/4 with their latest Red Seal K-4 of same size, which model also includes all of the latest improvements already recited for the J-4 motor.

Due to the unqualified satisfaction which North East generator with distributor and Exide Battery ignition has given in this Model also, its use will be continued regularly, but buyers may have the option of Eisemann High Tension Magneto Ignition, in connection with electric lights and horn, at an extra price.

Emergency brake will also be changed from rear drums to propeller shaft and the double braking surface in rear drums will be used for service braking, as described for the Model 65, 1 1/2-2 ton.

On account of the increased demand for 2-2 1/2 ton capacity for dump truck and similar exceptionally severe service, frame dimensions have been increased to 6x2 1/2x¼-in. and the front end will also be provided with an integral type of channel bumper.

Along the lines of seeking greatest user economy in operation the manufacturers will extend their former practice of equiping heavy duty Models (3 to 6-ton) with Gramm's patent Fuel Economizer, to the Model 20 also, without extra charge.

Models 65 and 20 will be furnished regularly with storm proof cabs with fore doors, or will be equipped with fully enclosed vestibule cabs, at a moderate extra price.

THE HUG SPEED TRUCK FOR ROAD BUILDERS

The Hug Speed Truck is a product of several years' of road building experience. Mr. C. J. Hug, a successful road contractor, realized the need of a motor truck especially adapted to road building service. He first designed and constructed an experimental truck for use on his own road contracts and the remarkable performance of this experimental truck under actual working conditions, its economy of time and money, dependability, efficiency and its practical service, led to the formation of a company to manufacture this truck and other road building equipment, The Hug Co., of Highland, Ill. The truck was built right into the road job for the job and designed throughout to meet the exceptional conditions existing on road construction work.

The fact that Mr. Hug experienced more or less grief with various makes of trucks on road construction work presented an opportunity to observe the various types of satisfactory and unsatisfactory units of the several different makes of trucks and enabled him to judge the proper weight and capacity of trucks available on the ordinary subgrade.

After these facts had been determined, an effort was made to obtain the proper units from the different parts manufacturers which were necessary to assemble the experimental truck to meet the conditions and do the work most economically. After a careful search among parts manufacturers it was found a number of the essential units were not being manufactured and it was therefore necessary to make those parts specially.

Records obtained from the many fleets of Hug Speed Trucks in operation today are indeed gratifying and particularly inasmuch as the truck has proven very successful wherever used. Some of these records are as follows: 51 cts. per

square yard, including all labor and operating costs on 16½ miles of pavement, on a job where the Hug Truck, Hug Turntable and Hug Subgrading Machine were thought out and developed. The result of this achievement was demonstrated on the Powell-Gavin Co. job near Waterloo, Illinois, where all Hug equipment was used with Hug idea of plant layout. A cost of 23 cts. per square yard is reported, or would represent a total saving on 16½ miles (laid with the kind of equipment used in common practice) of $41,160. The hauling cost on this latter job amounted to 6½ cts. per ton-mile for the entire job.

The truck was designed to carry either a six-bag batch of wet mixed concrete or dry aggregate. It has been repeatedly demonstrated that with the use of a central mixing plant and light speedy motor trucks to distribute mixed concrete direct to the subgrade, a concrete highway can be constructed rapidly and economically and meet—the most rigid specifications. The advantage of this method of construction is that the investment of the equipment is less than where some other methods are used.

The Hug Speed Truck with ample speed, a maximum speed of 45 miles per hour, and unusual power when required on road and grade, is able to meet the most exacting conditions encountered upon road construction work. The balanced position of the body on the truck is a special feature. Bodies of other designs may be substituted for this special body when the truck is not required for road work and the truck then is a speedy truck for general utility purposes.

PAVING OF MODEL SECTION OF LINCOLN HIGHWAY COMPLETED

The paving of the Ideal Section on the Lincoln Highway in Indiana, 37 miles south of Chicago and adjoining the Illinois state line, has been completed. Much remains to be done before the section is ready for dedication as the most ideally designed and constructed link in the transcontinental road, but the 40-ft., reinforced concrete surfacing, 10-in. thick, is finished.

The Section will not be open for traffic until the completion of the two bridges, which are expected to be finished before the first of the year. Stone & Webster, Inc., with headquarters in Boston, Mass., one of the Founders of the Lincoln Highway Association and that organization's main contractors, pushed the paving work with the utmost speed consistent with the highest possible quality of pavement, in an endeavor to complete the job in 1922. In this they had the fullest co-operation of J. C. O'Connor & Sons, the subcontractors, and of Lockwood, Greene & Company, Engineers, also Founders of the Lincoln Highway Association, as well as its engineers.

Final Touches in Spring

The completion of the pavement and the bridges does not by any means complete the Ideal Section. Early in the spring the proper grading of the shoulders, the landscaping of the right-of-way and the installation of the gravel pathway for pedestrians will be undertaken under the supervision of Jens Jensen of Chicago, the Association's landscape architect. The installation of the modern lighting system for night travel, designed by the illuminating engineers of the General Electric Company, will also be delayed until spring, but the heavy work of grading and paving is out of the way, and already the Model Section gives an indication of its ultimate appearance. It curves along the slight ridge formed by the once south shore of Lake Michigan, through dense growths of ancient oaks, between which from time to time glimpses can be caught of the open farmlands.

The Ideal Section, in addition to exemplifying the highest development of modern road design and construction, is located in an ideally beautiful spot, which offers infinite posibilities for the ultimate development of a campsite and rest-station for tourists which will become nationally known as a model for development all along the 3,300-mile road.

Section Repays Study

Those interested in modern highway design and construction will find even now much to see and study at the Ideal Section site, which is being visited monthly by many highway engineers and officials from every section of the Union whose business brings them to Chicago and who take occasion to inspect the progress on the most famous section of American road-building.

Leading engineers have expressed the belief that the 40-ft. paving laid on the Ideal Section of the Lincoln Highway will carry the traffic for which it was designed for an indefinite number of years without the slightest damage to the roadway.

Maintenance cost will be negligible. The actual cost of the paving was $62,000 per mile.

USING GRAVEL ON SECONDARY ROADS IN ILLINOIS

By B. H. Piepmeier, formerly Engineer of Construction, Illinois Division of Highays, Chief Engineer Missouri State Highway Department.

Gravel roads are economical, especially on secondary roads, when it is possible to secure gravel at a low cost.

On account of the change in traffic and traffic requirements, gravel road construction and maintenance have changed somewhat during the past few years. Experience has shown that it is possible to maintain a gravel surface in a satisfactory condition even under moderately heavy traffic, if the road is built properly and is maintained at the right time and in the right manner.

A few years ago it was considered advisable to utilize large pebbles in the building of a gravel road, and a large per cent. of clay binder (from 10 to 20 per cent.) to insure proper binding of the surface. Conditions have now changed to such an extent that the smaller material (1 in. and under), with practically no clay binder, proves more satisfactory. The gradation that affects the quality of the gravel more than anything else is the material passing through a ⅛-in. screen. If 100 per cent. of the material will pass through a 1-in. screen and 90 per cent will be retained on top of a ⅛-in. screen, and is free from binding material, the gravel surface can be maintained in a smooth condition by the use of the light maintenance grader or road drag. Should the gravel contain a large per cent of material over 1-in. in size, together with a large per cent of clay, it will prevent reshaping of the surface, and the result is that deep ruts and pockets will readily appear, thereby making it difficult to keep the surface in shape.

Another vital mistake that has been made in much gravel road construction is that of building the road with an excessive crown. An excessive crown forces the traffic to the center and this results in rapid rutting of the road. The most satisfactory cross-section for gravel road construction, under moderate traffic, is to build the roadbed from 26 to 30 ft. in width, with a perfectly flat surface, or a crown not to exceed 2 or 3 ins. On this roadbed 8 ins. of gravel should be spread over a width of 18 ft., and shaped so as to give a finished crown on the gravel of not to exceed 4 ins. The flat crown will permit traffic to spread over the entire metaled surface, and thereby prevent rutting and add materially to the life of the gravel surface. Material that is free from binder will rut very badly; hence it is much better to apply but 2 or 3 ins. of the material at a time, allowing each layer to be thoroughly compacted by traffic before the succeeding layer is applied. Where gravel roads are built by contract it is usually more desirable to have all of the material delivered on the roadbed during construction. When this is desired it would be advisable to dump the surplus material along the edge of the surface, where it could be readily dragged into place as the gravel becomes compacted under traffic.

When it is unnecessary to ship in gravel and the material contains from 10 to 15 per cent clay binder, the road should be built by first applying 5 or 6 ins. of the gravel and allowing the traffice to compact it thoroughly, after which it could be surface-treated with another application of the gravel, ranging from 2 to 4 ins. in thickness, depending upon the character of traffic that is going to use the road. The clay binder in the gravel is not so objectionable when the material can be hauled directly from the pit to the road. However, it is not possible to maintain the surface of the road in as good a condition when it packs under traffic. When gravel is to be shipped or hauled any distance it is very foolish to pay for transportation on clay, as there is usually plenty of the same binder on the subgrade of the road.

Approximately 75 per cent of the value of a gravel road depends upon the way it is maintained. Under our organized patrol maintenance, therefore, it is possible to utilize practically any local gravel that may be available and make a satisfactory wearing surface for secondary roads.

A general specification cannot be written to meet all conditions in gravel road construction. It is better, therefore, to study the pit from which the roads are to be built and then write a specification for the particular pit that will give the most satisfactory road.

The foregoing matter is the text of the discussion of the subject, "Gravel Road Construction," by Mr. Piepmeier, at the 1922 annual Highway Short Course held at the University of Illinois, at Urbana.

OBLIGATION OF STATE HIGHWAY DEPARTMENTS TO KEEP PUBLIC SOLD ON HIGHWAYS

By H. E. Hilts, Acting State Highway Engineer of Pennsylvania, State House, Harrisburg, Pa.

We know as road builders, we have something to sell; we know we have to sell it to someone, and we hope that we have some talking points to help us in disposing of it.

A study of the history of transportation shows the necessity for leadership and vision, because people as a rule have been slow in availing themselves of new ideas and new modes of transport. New ideas in transport, like all other commodities, have to be sold. Our present day commercial transport is sold and we are all more or less conversant with the methods used by our shipping service, and our inter-and intra-state carriers in selling their particular facilities to their clients, both by publicity campaigns and paid agents.

Still in Pioneer Stage

In the field of highway transport, a new mode of common carriage has rapidly developed. It is still young and is still in its pioneer stage of development. It is a mode which if used and promoted conservatively will augment, simplify and make more economical and commercially more remunerative both water and railway transport. If, however, its powers are spent in endeavoring to usurp the functions of the other carriers, it would seem that our new mode of transport will be retarded in its development.

In the light of common prudence the agencies of the people, the State Highway Departments, should play their part in giving the public authoritative information on highway transport, as it involves the roadbed and right of way.

Selling the Business Man

Broadly speaking, the pay transport is that of the manufacturing and commercial interests, and classified directly these interests have to be sold on the ideas of—(1) "Selective" carriage by the motor truck on our highways in contra distinction to the common carriage of the railroad, and (2) in the use of the motor vehicle for short haul traffic. This "Selective" carriage is that part of commercial highway traffic that has or will prove cheaper in total cost to the consumer, and it will, therefore, automatically be adopted by industry in preference to other methods of haulage as is evidenced by the moving of furniture, or other selective commodities, long distances in the thickly settled east, and the use of motor trucks by milk, produce, and other interests for movements up to one hundred miles. In general, the commercial interests are exponents of the value of good roads, but there has been a marked laxity on the part of the State Highway Departments in giving out information which is live information, and the spasmodic attempts by personal address have not carried the message of economical use to these people. The commercial interests are appreciating that the highway engineering profession consider road building in the light of a business proposition, and that as in all commercial enterprises, the money which is invested in a good road represents tangible value in giving a more even and satisfactory roadbed, a route that has eliminated rise and fall or distance. They are beginning to appreciate that if bond issue money is used, that tangible value should exist at the expiration of the bond period, and further, that the earning power of the road, which begins the day it is open for traffic, should more than offset the money required for upkeep charges, depreciation and obsolescence.

Highways as Feeders

The railroads are the sponsors for the trite remark that highways should be built as feeders to the railroads. There have been few highways built in this country that have not been feeders to the railroad. From the nature of the case, it would seem the greatest feeders entering a given town are ones that carry the most traffic to and from the town and, therefore, our primary routes are the ones that should be first improved with modern thoroughfares. Many times this viewpoint does not seem to take into consideration the fact that automatically the semi-feeders, the secondary roads, are being constantly maintained and strengthened from current taxation, and that industry can accomplish much by strengthening the aims of the State Highway Department in its endeavor to have local road revenues spent to the best advantage. The road builder, the motor truck manufacturer, and the railroads have a common interest in selling the road user reasonable selective traffic, and the sale of the idea that a reasonable load should be carried within the legal limits of speed, and in a vehicle that meets all legal requirements. We must not lose sight of the fact that the real

birth of truck traffic was during stormy times, and that overloading and its attendant evils were thrust upon the highways before the remedies could be applied. It would seem that the general crystallization of ideas of all the interests involved is leading to a more conservative gross vehicular load and wheel load, and the research work which has been conducted by the Bureau of Public Roads, and several of the State Highway Departments is being practically interpreted to mean more conservation on the part of all interests in the general interest of the good roads movement.

The Electric Railway

In the case of the electric railway, we have to handle a different educational sale. The electric railway during its relatively short growth automatically found its level as a feeder or helper to the railroads. It searched out corners of our country which could not be reached economically, due to physical conditions, by the steam lines, and it has done much to raise the tone of the communities it serves. Generally, many of these lines have broadened their activities so as take in the power or lignting fields. Thus they have automatically become super-public-service corporations. The motor vehicle in its earlier day did in its unregulated field offer grave competition, as it noted in the jitney craze of ten years ago. It was quickly proven, however, that the widespread use of jitneys was economically unsound, and we now find the regulated motor vehicle used as a common carrier of passenger traffic. In the large centers of population, it has become the taxi, or motor bus, which is recognized as a selective carrier augmenting the electric lines, and it is regulated in its service by the Public Service Commissions, whether or not it competes with existing steam or electric lines. Automatically, this method of common carriage is being sold to the public by necessity, and in its turn it makes for the use of more and better highways. It is interesting to note that the widespread use of commercial bulk haulage by motor truck for long distances has yet to prove its economy.

Highway Financing

The largest class of road user, the owner of the pleasure motor vehicle has as yet to be sold the salient idea of highway financing. He does not yet realize that roads cost money, that definite road policies of construction, maintenance and administration are necessary. He does not realize that he has a vehicle that is dangerous to his fellow man when improperly used. The courtesy of the open road has not as yet made its appearance. If the road official does not take in hand and continually sell and resell the idea of road courtesy, he is leaving one of his greatest assets dormant. The selling of such stock phrases as "The man on your right has the right of way," the selling of ideas of correct lighting of motor vehicles, the courtesy of remaining on your own side of the road, the heeding of warning, danger and direction signs, the use of judgment in approaching grade crossings, all are tangible set ideas which all road users should be taught, and in being taught they gradually imbibe a more wholesome respect for the road and their fellow man.

It is interesting to note in this connection that gradually the owner of a motor loses his individualism. As his radius of travel increases he realizes that good roads do not mean just a road for his own locality, but that he must broaden his vision and his efforts so that his township, his county or his State are made accessible if he is to derive the full benefits of his new investment. We will always have the stay at homes who will never appreciate the growth and progress of the country as a whole and they, as in the past, will be the greatest opponents of highway progress, but even they are not hopeless as far as highway education is concerned. A few of the states have fostered the touring idea, not in the broad sense of the national automobile associations, but in the more homely and restricted sense of giving local news items for the smaller dailies and through channels of this kind must the stay at homes be reached.

Correlating All State Agencies

In all this educational work many look to the State Highway Departments alone. However, this is a restricted viewpoint. If we are to make surer and quicker progress, we must correlate all of the agencies of the state. The business man's viewpoint must govern and regulate the many activities of a state administration, the several departments of the state administration having much in similarity to the departments of an active, well managed business enterprise. In business the exchange of ideas between these departments is conducive to the success of the several departments and the enterprise as a whole. The problems of design, construction and maintenance, and the problems of economics of the

highway department are closely associated with the inter-department co-operation of the State Department of Agriculture, which is intimately associated with the needs for rural transportation. In the Eastern states the neglect of agriculture is the paramount cry of those interested in this phase of human endeavor; in the middle and far West the reverse is the case; but in either event, it has been one of the inconsistencies of American progress that the farmer's car has been allowed to remain in the mud. If more attention is given to the construction of good roads, towns will widen and stabilize their trading zones, and agriculture will again in the East, draw its people back to the farm, and thus place life on a more equable plane. The State Department of Education appreciates that hand in hand with its endeavors should go the endeavors and thoughts of the Highway Department, and yet how few and far between have been the spasmodic attempts at co-operation. The graded school can replace the old red school house only after good travelable roads have been built, because only then can every day travel be accomplished. Yet how seldom is this reflected in the co-operative educational efforts of these Departments. In turn we could discuss joint co-operation with State Departments of Commerce, of Internal Affairs, of Water Supply and Forestry, of Labor and Industry and of Public Service Commissions, and yet, how seldom is this co-operation actually sought by the departments in question.

Highway Department Must Be Respected

The obligation of the State Highway Department is not fulfilled merely by selling ideas, for before it can sell anything it has to, like any other business enterprise, have the healthy respect of the people for both its purposes, its judgment and its work. If the people are led to believe that its purposes are political, that its judgment is biased and its work is poorly handled and wastefully done, it can't sell ideas. Therefore, when the general policy of a live department is decided upon, after definite and long continued conferences with the people and with the interdepartmental divisions, let the people know—don't hide it. Expenditures are large, tens of millions of dollars yearly in many states, and the making available of funds in future years will be one of the jealous prerogatives of future Legislatures. State programs always will depend upon the Legislatures as representing the will of the people; therefore, public opinion should be courted. Much has been said of decentralized control as against centralized control. If the public are informed by impartial observers who know the work that the department is a real going concern, if they appreciate that there is a definite policy, close financial control, rigid construction standards, real teamwork in the organization, then they can appreciate that the selling arguments are sound. The concomitants that go with this definite appeal to the public, however, are sound engineering skill in maintenance and construction, and real business contract co-operation with the contractors who accept the state's business.

Establishing a Policy

Probably the most important single step that a department takes is the establishment of its policy. Many experts and laymen believe that policy represents the ideas of one man or a group of men. In some cases, this is probably true. It would seem, however,that a strong basic policy will stand only after it represents the consensus of opinion of the thinking people of the state. For instance, prior to beginning the program that has been carried out in Pennsylvania during the past four years, the late Commissioner Lewis S. Sadler, after wide publicity and hundreds of interviews with interested delegations, concluded that it was the idea of the people of the Commonwealth that assessed valuations and county lines be ignored in planning for the construction of the Pennsylvania primary highway system, that the viewpoint of the people was to construct a trunk line system connecting centers of population within the State and without the State by reasonable connections with the primary systems of adjacent States. The whole cost of the primary system was assumed by the State, the counties being urged to use their available funds in the construction within their limits, of the secondary system as constituting roads of local importance but not used by the public within the State as a whole. The secondary system could be built either in co-operation with the counties on a 50-50 basis, the State funds coming from Legislative appropriations, or by the county on a bond issue or current revenue program. As a further policy, which was given publicty in the press throughout the State, it has become generally known that the State is empowered by Legislative enactment to do the engineering work.

award contracts, and superintend construction on the request of any county, the county meeting only the cost of construction work. This enactment has sold to the majority of the counties, the services of an organization equipped to handle their construction work with economy, efficiency and dispatch under standardized State wide methods. Establishing a policy is only one step—it should thereafter be given wide publicity.

Economics of the Road

There are other policies that are as important as a broad general financial policy. One of these is that which deals with the economics of the road. In Pennsylvania, for instance, one of the great industrial States of our Country, we had prior to starting our program, just gone through the trying transportation difficulties of the War. The heavy use of our roads in augmenting the steady flow of war materials by rail brought out in a startling and definite form, the fact that our main trunk highways were not sufficiently strong to withstand the constant flow of supplies by motor truck from the midwest to the embarkation points on the seaboard. This experience is still fresh in our memories, and to my mind this period, from 1917 to 1919, will be considered as a turning point in our conception of the use to which our primary roads may be put in a time of stress, or a great national emergency. An analysis of this emergency by the public and the engineering organization developed the policy, which was given wide publicity in the press, of constructing primary roads of the so-called durable types in active competition, when the Engineering Division was satisfied that there would be real competition, the work being awarded to the low bidder, irrespective of type. This policy has been rigidly adhered to for the past four years. If a low bidder fails to qualify, his bid is rejected and the work is readvertised. Another policy, which has been given wide publicity in our State, is that if an improved road is needed, it, like any other commodity, has to be bought in the open market. It naturally follows that in a period of high or uncertain prices, large construction programs may needs be deferred, and only the most important construction links be given consideration.

Influence of Engineering Standards

It is not self evident that engineering standards of construction can help to sell the public the roads it needs. However, it is rather striking to find that delegations of laymen who visit headquarters will spend considerable time looking into standard bridge practice, look over specimens of road surfaces, and in every delegation there are a few men who appreciate that the present highway engineers are entering in a new field of endeavor; that they are not following out rule of thumb methods of guessing at this or that, but that slowly they are attempting to evolve logical engineering designs to fit the needs of the loads which are or may become legal, and therefore used. The bold designs of the past are being replaced by conservative standards which in the future will bear the light of increasing scrutiny. More and more as the light of truth creeps into the field of highway engineering, the failures of the past will be shown up in their true light as failures, not so much of engineering as of the system under which roads have been built; the system which on the one hand calls for extended mileages of secondary types, and on the other for short mileages of wide suburban thoroughfares. It is true that some engineers still live in the memories of the past; they think in terms of 1910. In 1910, Pennsylvania only registered as many motor vehicles as have been registered in a single day during a recent month.

Correlating Construction with Maintenance

Probably one of the most important field policies, and one on which the public must be not only sold by telling, but repeatedly sold by retelling, is that of correlating construction with maintenance. A workable theory is that maintenance means not only the maintenance in the densely populated states, of the old roads, but also the improvement by current revenues of the rural roads which are in a primary system, and which are not yet susceptible to the expenditure of bond monies for their improvement.

When the maintained main routes become increasingly burdensome year by year, not only on account of maintenance or other expenditures, but also on account of burdensome hindrance to economical vehicle or transport operation, then correlate these sections by durable construction. This correlation means a detailed study month by month, and year by year by the Maintenance and Construction Engineers; it means study not only in the field, but also in the office after yearly charges have been segregated. An annual program involving 500

miles of resurfacing year by year; surface treatment of 1,800 miles a year, and construction of durable types at the rate of 500 miles a year must need be correlated, so that economical expenditures be planned and made, and the details of a program of this character have to be sold to the public through the press, and by pointed constructive talks and lectures. The public must be made to realize that highway work is a great continuing business which cannot be tampered with.

Attaining General Understanding

This sale is not all accomplished by cold type and conservative oratory. The most convincing public official I have ever met, a man who had the keen insight of a financier, the logic of a successful business man, and who unknown to himself immediately gained the confidence of his constituents by personal conferences with legislative committees, with County Commissioners and representative citizens, did not look upon visitors at headquarters as pests or ingratiating individuals who called because they wanted something. To him they were the individual through which he could talk to hundreds, to him they appeared as the representatives of their districts, and he would spend hours in conference, enlarging upon viewpoint after viewpoint, and gradually drawing their interest closer and closer until there was mutual understanding. All executives cannot be of this type, because it is exhausting of both time and energy, but to a man who can draw an efficient, enthusiastic corps about him selling his constituents is his big side line.

The total yearly volume of sales of a State Highway Department to the people of a state is anywhere from $12,000,000 to $45,000,000 per state, striking an average of say $20,000,000. Can we gather any light by comparing this average department with an efficient corporation doing this gross business a year? Does the corporation spend money to make sales, does it spend money to create desire for goods, does it spend a conservative sum for research and for increasing the efficiency of both the employee and the plant, and when all is said and done are these sums conservative with the ends achieved? You will say yes. Analyze the Municipal, County or State Highway Department. Does it usually make any effort, not to spend money for publicity purposes, but to create desire for roads through channels that are opened freely to them, does it allow in its budget anything for research or refined design practice, or does it organize for efficient publicity work? Most of us will admit broadly—no. Still when the public asks as to taxes, indifferent service, poor maintenance, misinformation, inferior detours, unanswered construction complaints, and all the other miscellaneous complaints that buzz throughout the year, we find that they all can be summarized to come under the broad general publicity outline. The only conclusion that can be drawn is that we haven't still perceived the business man's viewpoint.

Enthusiasm must be created for our work, our job and the things yet to be accomplished, because in the end it is the spark of enthusiasm that sells or builds or creates great enterprises.

The foregoing matter is from the paper by Mr. Hilts before the recent annual meeting of the American Road Builders' Association.

FEATURES OF NEW WELL WATER SUPPLY AT MEMPHIS, TENN.

By J. R. McClintock, of Fuller & McClintock, Consulting Engineers, Produce Exchange Bldg., Kansas City, Mo.

An interesting well water development is now under construction for the city of Memphis, Tenn., as a result of a careful investigation of the city's water supply made during the latter part of 1921 by Fuller and McClintock, engineers. The new works will comprise a complete new pumping station, with covered equalizing reservoir, iron removal plant and aerating devices, supply mains to the distribution system and a new system of wells as a source of supply. This development is known collectively as the Parkway Station and will replace all of the present municipal supply and pumping facilities. The present population of the city is about 175,000.

The Gathering Ground

Memphis is fortunate in possessing underground strata which yield abundant quantities of soft, pure, cool water. These strata comprise sand layers, of varying degrees of fineness and of a total depth of several hundred feet, known as the LaGrange formation. This formation is overlaid at Memphis with 300 to 400 ft. of impervious clays but outcrops about 25 miles east of the city for a width of many miles, this outcrop furnishing the collect-

ing area. In earlier years a few artesian wells were secured in the LaGrange formation at low points but, in general, at the present time the hydrostatic level is 25 ft. or more below the ground surface.

The city has obtained its entire water supply from wells in this strata for some 30 years and there are a large number of private wells supplying hotels, industrial plants and other buildings. The average daily consumption of water from the municipal works is about 80 gals. per capita and an equal quantity is estimated to be obtained from other wells. The water is remarkably soft for a ground water and entirely free from contamination, where the wells are properly protected from surface leakage. In certain wells, however, appreciable amounts of iron are found which make the water objectionable for laundry purposes, and the well water generally contains about 110 parts per million of free carbonic acid rendering it exceptionally corrosive.

Serious consideration was given to a filtered supply from the Mississippi River before deciding upon a new well supply. While such a supply would be feasible, and with suitable purification works could be made reasonably satisfactory, the establishment of a safe and stable intake would be very difficult and expensive on account of the shifting character of the Mississippi River at Memphis. Careful estimates of cost indicated clearly that both the investment cost and the operating charges would be substantially higher for a filtered river supply than for a ground water supply.

Air Lift Pumping Adopted

It was recognized that any method of pumping water in large quantities from deep wells was bound to be relatively inefficient. Careful comparisons were made of the advantages of electrically driven deep well pumps as compared with the air lift. With properly designed equipment and efficient machinery the total cost of raising water by means of the air lift was shown to be less than with electric driven well pumps, taking the overall efficiency from coal pile to water and making due allowance for probable maintenance and repair expenses.

The simplicity and reliability of the air lift, particularly the freedom from moving parts, requiring oiling and subject to wear, make it a more satisfactory method of pumping the wells than centrifugal deep well pumps with high speed runners and long shafts located at inaccessible places deep in the wells. Further advantages of the air lift are the flexibility with reference to variations in lift as well as the ability to deliver overloads. By varying the locations of the foot pieces and the quantity of air supplied it is readily possible to adjust to wide ranges in conditions as regards draw down and capacity, and yet maintain reasonably good efficiency.

The assumption of an overall efficiency of 25 per cent from the steam indicated horse-power of the compressor to water horse-power, which was used in comparing the air lift with deep well pumps is believed to be materially lower than can be readily secured in practice. At a number of places elsewhere, notably Madison, Wis., and St. Paul, Minn., air lift efficiencies of 35 to 40 per cent. have been secured in regular practice with suitable equipment and careful attention to the operation of the plant. At Memphis it is proposed to provide all necessary equipment and to design the plant so that the very highest efficiency may be maintained. To this end instruments will be provided at each well for measuring the flow of air and water and the air pressure at the well, and recording the water elevation in the well.

The air supply to each well will be regulated by valves or controllers in such a way as to prevent the excessive rush of air through a single well that might result from improper adjustments of the foot piece to the air pressure maintained, and from variations in draw down. Air lines of liberal size are to be used to minimize friction losses in delivering the air from the compressors to the wells. It is proposed to run a series of tests on each well and modify the submergence of the foot piece so that it will be closely adapted to the air pressure carried and the lift prevailing at that particular well. An economical average ratio of submergence for the entire group of wells will be selected so that they can all operate properly on practically the same air pressure. In general it is planned to provide sufficient wells so that they may operate with an economical draw down rather than attempt to secure a certain maximum capacity from each well.

Metering the Air Supply

As a check on the total amount of air delivered to each of the four groups of wells a Thomas thermo-electric meter will be placed on each main air pipe at the Parkway Station. These meters will give accurate readings of the amount of air delivered under varying conditions of

pressure and temperature and will be used also in determining the delivery of the compressors during the duty tests.

Preliminary experiments are to be made on some of the existing Memphis wells to determine the merits of different types of air gauges, controllers, foot pieces and meters and particularly to develop the practicability of a more efficient type of eduction pipe. Owing to the necessarily high velocities in eduction pipes the friction losses are considerable in any case, and rapidly increase as the interior becomes corroded as occurs with steel or iron pipe. Due to the expansion of the air in the rising column of water the velocities at the upper end of an eduction pipe are higher than at the bottom unless the pipe is tapered or enlarged. A tapered eduction pipe is therefore to be tried, made up of lengths of copper tubing varying by about ⅛ in. in diameter, slightly flared at one end and brazed together. Although such an eduction pipe would cost considerably more than one of steel, it is believed, if it is mechanically feasible, that it will materially improve the efficiency of the air lift.

The air lift possesses a very important advantage at Memphis, as evidenced by numerous careful tests, in that it removes 80 per cent. of the free carbonic acid. For a thoroughly satisfactory supply the carbonic acid should be completely eliminated in order to furnish a water without corrosive properties. As a result of various experiments it was determined that the free carbonic acid remaining in the air lift water could be reduced to about 5 parts per million by means of an aerating device of suitable type. If desired this small residual quantity can be removed by the addition of a little lime.

Aerating Equipment

The aerating equipment found to be most advantageous consists of a series of four trays, each about 10 ins. deep, containing broken coke and superimposed one above the other with open spaces about 9 ins. between the trays. The trays will be built as a series of 40 units, each about 2 ft. wide by 7 ft. long with wide air spaces between to allow free circulation of air. With such an arrangement the water can be properly aerated at a rate of about 30 gals. per square foot of aerator per minute. Water will be distributed over the top trays by troughs with perforated copper bottoms. The aerating units will be built of concrete with bottoms of copper or brass wire mesh so as to avoid corrosion or decay of any portion of the structure.

Iron Removal

The iron in the Memphis well water can be readily removed after aeration by filtering through sand at rates commonly used for mechanical filters. A complete rapid sand filter plant is being built which will remove the iron and at the same time furnish protection against any accidental pollution of the well water on account of leaky well casings or from other causes. This plant will comprise eight filter units of 2.25 million gallons daily capacity each, with concrete tanks and wash water gutters and a strainer system of perforated, galvanized wrought iron pipe. Hydraulic gates and operating tables will be provided for controlling the filters as well as rate controllers and loss of head gauges. The filters will be washed by water from a concrete tank in the top of the head house at the so-called "high rate." In the head house ample space will be provided for laboratories, offices, toilet rooms and for storing lime, and duplicate dry feed machines installed for applying lime to the aerated water.

The Wells

The proposed system will comprise about 20 wells spaced about 500 ft. apart and located partly on private lots along a beautiful parkway in the north end of the city and partly along a strip of land which has been purchased by the Artesian Water Department for the purpose. There will also be four wells located on the new Parkway Station site. The wells will have 12 in. steel casings with 50 ft. of 10 in. brass, well strainer of the Cook type and at the top will be provided with an additional 18 in. casing. It is expected to secure a yield of about one million gallons daily from each well with a draw down of about 25 ft. The estimated average pumping lift from the wells to the surface is about 75 feet.

The well houses will be designed so that a portable steel derrick can be mounted on the roof in case it should be necessary at any time to reset the well strainers or withdraw the casings. Drains will also be provided at each well to remove any waste water which may result from cleaning out the well.

Structures

The entire development is being constructed in a first-class, substantial manner throughout. Both the Parkway Station and the wells are located in a high class residential district and every effort will be made to make all structures at-

tractive and pleasing to the adjoining property owners. The pumping station and the superstructures of the iron removal plant and aerator will be constructed of high grade, tapestry brick with Bedford stone trimmings. The main floor of the pumping station and iron removal plant will be floored with red quarry tile and the interior walls are to be lined with light grey semi-glazed brick. All structures will be entirely fireproof throughout. The storage reservoir will be covered with 2 ft. of earth and sodded, and it is proposed to construct six tennis courts on top of it. Each well head is to be housed in a neat, tasteful little building of tapestry brick and cut stone and the entire lot on which the well is located neatly graded and planted with grass and shrubs. Likewise the entire Parkway Station site will be attractively parked.

Capacities

The average daily capacity of the entire plant is about 18 million gallons, but the wells, aerator and iron removal plant are designed to carry temporary overloads of 50 per cent. to take care of maximum periods of consumption. The storage and equalizing reservoir will have a capacity of 10 million gallons which will be ample to supply any probable fire draft and provide for daily peak rates of consumption. The high lift pumps will comprise two horizontal crank and flywheel units and two turbine centrifugal pumping units, each with a net capacity of 15 million gallons daily. There will be four cross compound air compressors, each with a capacity of 2,700 cu. ft. of free air per minute. It is expected that this Parkway development for a period of 8 or 10 years will furnish the water supply of the entire city and that it will permanently provide for the western section of the city, including the main business and industrial district. In the course of a few years, however, it will be necessary to construct a second station to take care of the rapidly growing eastern portion of the city.

Station Details

In planning the pumping station careful study has been given to arranging all equipment and piping so that the failure of any single portion will not impair the capacity of the plant to supply maximum demands. A complete header system has been provided for the high service pump discharge lines, with an elaborate arrangement of valves and cross connections to guard against any possible break that might occur. This same principle has been followed with all the auxiliaries and steam and other piping about the station. In order to concentrate the machinery to facilitate convenient operation, the four air compressors and four high lift pumping units have been placed in a double row with their steam ends along a central aisle. This has necessitated a clear span of 120 ft. for the roof of the pump room which is 160 ft. long.

A complete system of gauges and measuring devices is being installed throughout. Venturi meters are provided on the discharge lines of each high service pump and also on the raw water line to the aerator. Full sets of gauges are to be provided for all pumping units, air compressors, boilers and auxiliary machinery. The boilers will be equipped with automatic furnace control systems, Bailey boiler meters and CO-2 recorders. The hydraulic valves of the header system will be controlled from an operating table in the pump room.

Centrifugal Pumps and Turbine Water Wheels

The water from the wells will be delivered by a gravity conduit to the equalizing basin of about one million gallons capacity. In order to deliver the well water to the top of the aerator it will be necessary to lift it about 26 ft. This will be done by means of centrifugal pumps operated by small turbine water wheels which will be driven by pressure water taken from the discharge of the high lift pumps. After considerable study it was determined that this method of pumping would be cheaper than using small turbines or electric motors for driving the pumps, owing to the low steam consumption of the high lift pumps and the comparatively good efficiency of small water turbines.

Boiler Plant

The boiler plant will comprise four 350 horse-power units of the horizontally inclined water tube type designed for 225 lbs. operating steam pressure. Each boiler will be set separately and equipped with an underfeed stoker. Draft will be provided by a 9 ft. by 225 ft. radial brick chimney as well as by an electric driven fan for each stoker. The boilers will be equipped with superheaters, two units being designed for 75 degs. and two for 200 degs. so that the advantage of different degrees of superheat may be tried out in practice. The boilers, stokers and appurtenances have been planned to operate efficiently under wide variations of load to avoid the waste of banked fires as far as possible in operating the station at differ-

ent capacities. Modern coal and ash handling equipment is to be installed with a 500-ton suspended steel coal bunker above the firing aisle.

A Great Well Water Development

The new Memphis plant will be one of the largest municipal well water supplies in the United States and in many respects the most completely equipped. The total cost of the works will be about $2,500,000, including the main supply lines from the new pumping station to different points in the distribution system. The works have been designed by Fuller and McClintock, engineers, and Mr. F. G. Cunningham is resident supervising engineer for them in directing the construction. The architects for the superstructures are Messrs. Jones and Furbringer of Memphis. The entire project is being carried out by the Memphis Artesian Water Department, Messrs. F. G. Proutt, chairman; Milton J. Anderson, vice-chairman, and Thomas F. Stratton, commissioner. Mayor J. Rowlett Paine has shown the keenest interest in pushing forward this much needed betterment for the city of Memphis.

THE CORROSION OF UNDERGROUND STRUCTURES

By E. R. Shepard, Consulting Electrical Engineer, 1620 Edison Bldg., Chicago, Ill.

Corrosive Action of Soils

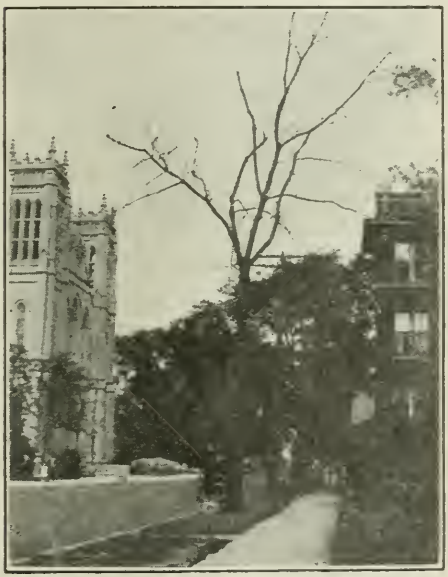
Underground piping systems are often considered as practically indestructible and when once installed as requiring no further attention or replacement. As a matter of fact they are always subject to deterioration and, under certain conditions, to very rapid and serious destruction. The chief causes for the rapid corrosion of pipes are to be found in: (1) Naturally corrosive soils; (2) Filled ground containing cinders, ashes or other foreign matter; (3) Electrolysis brought about by the action of stray electric currents, usually from trolley lines.

Among the corrosive soils should be mentioned those containing organic acids, which are formed by the process of vegetable decay. Such soils include muck and peat and are found in the alluvial deposits of the Mississippi River and in other swampy areas. Some kinds of alkaline and so-called alkaline soils occurring in the western states and in some portions of British Columbia and Manitoba are also destructive of iron and lead pipes. Salt marshes are not only corrosive to a certain degree but accelerate stray current electrolysis because of the low electrical resistance of the earth. The same may also be said of wet, black soil containing considerable organic matter, as these are usually found to have a low electrical resistance.

Cinders, ashes and filled ground containing refuse often produce extremely acute and rapid corrosion of piping systems. This corrosion may be electrolytic in nature, resulting from galvanic action between the metal pipes and the cinders or other foreign matter. Because of this it is difficult and often impossible to dstinguish between corrosion of this character and that produced by stray currents.

Difference Between Soil Action and Electrolysis

Even now after years of research and investigation there remains a great deal of uncertainty regarding the causes of pipe corrosion in many instances. Corrosion is often attributed to stray current action where the soil itself is a partial, if not the sole, source of destruction. Since chemical action is primarily an electrolytic phenomena, it is not possible to distinguish between such action and that caused by stray currents. Stray current action is often more rapid than natural rust or soil corrosion, and in the absence of sufficient oxygen, may produce the black or magnetic oxide of iron instead of the red oxide commonly known as rust. This is really the only difference



VIEW OF TREE KILLED BY GAS LEAKING FROM CORRODED PIPES

in the appearance of corroded pipes by which stray current electrolysis can be distinguished from ordinary soil corrosion, and even this test is far from reliable.

Circumstantial or contributory evidence is often to be found in the location on the pipe where the destruction takes place. Water and gas pipes and particularly service pipes often show local corrosion under street car tracks, or at points of intersection with telephone, or electric light cables or other lead sheathed cables which are electrically drained to the railway negative bus and are, therefore, lower in potential than the piping systems. Where highly localized or concentrated damage is found at such intersections, the evidence is pretty conclusive that it has been caused by a discharge of stray current to the other metal structure. Where the corrosion is general and no other structure is nearby, there is always a question as to the cause of the damage even though the pipes may be positive to a car track on the same street. As a rule electrolytic corrosion of pipes is not serious except at intersections with, or close approach to, electric railway tracks or other underground structures.

The fact that gas and water services of wrought iron and steel may have shown a more rapid rate of deterioration during recent years than prior to the installation of electric railways does not necessarily throw the responsibility for such damages on the railways. The manufacturing processes by which steel and wrought iron pipes are made have undergone such changes as materially affect their composition and structure, and it is a well known fact that modern materials are much more subject to corrosion than those produced by the older methods. This condition alone is no doubt responsible for the short life that is experienced by pipes in many localities.

Experiments by the National Bureau of Standards

A knowledge of the effects of different kinds of soil on the corrosion of buried metal structures was considered of so much importance that a year ago the American Committee on Electrolysis, in cooperation with the National Bureau of Standards, and a number of pipe manufacturers,instituted a comprehensive and nation-wide investigation of the subject. Thousands of small samples of different kinds of pipe were prepared by the manufacturers, and these have been buried in about 40 locations widely distributed throughout the entire country. All kinds of soil and climatic conditions have been included in the tests. Several samples of each kind of pipe are included in each set which will permit of unearthing them progressively over a period of years. Every sample was carefully weighed and the loss of weight resulting from soil corrosion can, therefore, be determined in an accurate and scientific manner. It is expected that positive results will be obtained in a period of two or three years and more definite results will develop as time elapses. These tests will be independent of any stray current action and are designed solely to determine the effects of different soils on different kinds of pipe, including lead, cast iron, steel, wrought iron, as well as some special materials. The whole investigation is being carried out in the most thorough manner by the Bureau of Standards and is being watched with great interest by the manufacturers and users of pipe.

The results of these experiments should be helpful in determining to what extent stray currents are responsible for the large amount of corrosion, particularly on steel and wrought iron pipes, that is in progress in most of our cities.

The Earth Current Meter a New Instrument

Another important development which is enabling engineers to differentiate more clearly between stray current electrolysis and soil corrosion is the earth current meter which has only recently been perfected by the Bureau of Standards. Instead of measuring the potential difference between pipes and adjacent car-tracks, which is not a reliable criterion of the hazard to which the pipes are exposed, the earth current meter measures directly the density of current discharge from the pipe surface to the earth. This instrument is now available, and where the necessary time and effort is given to its application, results can be secured, the validity of which cannot be questioned.

Damaged Pipes Still in Service

Pipes are often badly damaged if not totally destroyed long before actual failure takes place. This is particularly true of cast iron mains and low pressure gas services. When cast iron is corroded by stray currents there is left intact a residue of carbon and iron oxide which is strong enough to withstand gas pressure and even water pressure. It is not an uncommon practice in some cities to remove water mains which have been so badly damaged by electrolysis that holes

can be cut through them with a pocket knife. This is obviously a dangerous condition as failure is most likely to occur during a fire when the pressure has been increased. Cast iron gas mains are seldom replaced on account of corrosion as they remain gas tight even after the iron has been largely removed. It is also remarkable to what extent wrought iron and steel services can be damaged and still remain substantially gas-tight. This is particularly true in dense clay soil. It is true, of course, that leaks may occur as soon as the wall of the pipe is punctured, but on the other hand, service is often maintained with little or no leakage of gas through services that are almost totally destroyed.

This condition introduces another difficult factor in the problem of ascertaining the cause of corrosion. Pipes are often uncovered or removed which show severe corrosion, and the question always arises as to whether the electrical conditions which prevail at the time of the examination are responsible for the damage or whether some previous and unknown condition associated with the operation of the electric railway or the bonding of the tracks was the cause.

Corroded pipes are always a source of danger and many fires and explosions have been traced to leaks resulting from such conditions. Leaks from gas pipes may manifest themselves by the odor of gas in buildings or streets or by dead grass or trees. Escaping gas dries out the earth, thus destroying vegetation and in some cases it may also have a toxic effect. Escaping gas often finds its way into street conduits, vaults and buildings where it may be ignited with serious consequences. This happens most often in winter when leakage cannot take place through the frozen earth crust.

Electrolysis Prevention

Space does not permit of going extensively into the various methods of eliminating or improving electrolysis conditions, but a brief discussion of a few of the accepted methods of mitigation may be helpful to those who are not familiar with this phase of engineering.

Pipe coverings in the nature of dips or wrappings have not proved to be effective in preventing stray current action for any considerable period of time, although such protective coatings are of distinct benefit where soil action is the principal source of damage. Insulating joints in mains are often used to good advantage, but their locations should be selected by a competent engineer with full knowledge of the pipe network and the electric railway circuit. Insulating joints in individual services have not been extensively used, perhaps because no satisfactory inexpensive joint has yet been developed. Great possibilities for protection lie in insulating individual services which cross under street railway tracks, as this is the most frequent source of damage. In order to be effective the service must be insulated both at the main and at the meter to insure against current entering by way of gas water heaters.

Some companies have made a practice of laying two mains on streets occupied by car lines where electrolysis conditions have proved to be very bad. This practice enables them to run short services to their customers without approaching the car-track, and where this is possible little or no trouble has been experienced. It is not possible here to take up the merits and demerits of electrical drainage of pipes as a means of electrolysis mitigation. The practice is taboo with a number of gas companies because of their aversion to inducing currents to flow over their mains and making them a part of the return circuit of the electric railway system, with possibility of fires and explosions that may result from such currents. On the other hand, many gas and water companies have protected their system by the use of electrical drainage.

None of these methods enumerated really strike at the seat of the electrolysis problem which is primarily one for the electric railways to take care of. While it is not possible completely to insulate their rails from the earth and thereby prevent the escape of current to the earth, it is possible by good bonding and a sufficient number of substations and return feeders so to reduce the voltage drop on the tracks as to eliminate, in a large measure, stray currents from the earth and underground structures. The matter of electrolysis prevention is now being given more attention by the railway companies than it was in the past, and although in many places serious damage is still in progress, it is by no means as prevalent as it was in the early days of electric railways. There is also a growing spirit of cooperation between the railway companies and other utilities which enables them to handle this problem jointly and to the best interests of the public. Local electrolysis committees have been organized in a number of cities which represent the best practice at this time in electrolysis prevention.

HIGHWAY BRIDGE CONDITIONS IN MASSACHUSETTS

By William F. Williams, Commissioner Massachusetts Department of Public Works, State House, Boston, Mass.

Of the many interesting problems before the Department of Public Works of the Commonwealth of Massachusetts, perhaps no one of them involves the elements of safety to life and property more than the highway bridges of the state. For about two years a bridge survey has been carried on largely by mail through the Selectmen of towns and engineering departments of the cities, although Boston and larger cities have been omitted for the time being.

The survey has also been confined to bridges 20 ft. or over in length, notwithstanding the department draws the line at 8 ft. and anything of a shorter span is classified as a culvert; but the Federal Government limits its assistance to bridges over 20 ft. in length. The principal reason, however, for eliminating bridges under 20 ft. in length was to get a quicker inventory of the more important structures whose repair or replacement to meet the conditions of modern traffic would require special consideration structurally and financially.

It should also be stated at this time that most of these bridges are owned and maintained by the town or county in which they are situated, although the character of the traffic is largely determined by the condition of the highways built and maintained by the state.

The present inquiry is also limited to securing only a general description of the bridges covering location, dimensions, age and present condition, and from the returns so far received we find there are, outside of the large cities, over 500 wooden bridges and about 450 iron or steel bridges that must be extensively rebuilt or replaced by new structures within varying periods of time, but not exceeding 20 years.

From this brief statement, you will realize the size and gravity of the bridge problem that confronts the towns and the Commonwealth, and the necessity for the adoption of a policy that is safe and economically workable.

In arriving at the probable strength of these bridges, it is reasonable to assume that the wooden bridges were built by rule of thumb, and the stresses were not actually calculated. It is evident, however, that the iron bridges were carefully designed to meet the load requirements of their period.

It is also an interesting development of the survey that many of the old bridges, both wood and iron, are much stronger than they are popularly supposed to be. If it were not for this fact, the Commonwealth would be confronted with an appalling financial problem.

There appears to be a general tendency to forget the original factor of safety in casually considering the strength of an old bridge. The average person is also more or less affected by the looks of the structure and especially by the noise caused by loose planks and the rattle of counter rods in iron trusses, especially in the pony type. It is too true that very few iron or steel bridges are kept properly painted. In some cases the neglect is so apparent and the results so serious that it is difficult to understand how the officials in charge escape public censure. Our investigations have also shown that the metal work of the old wrought-iron bridges is in remarkably good physical condition and even the more modern steel bridges, that are not near salt water, have not suffered as much from corrosion as might be expected from a casual view. It is all too apparent, however, that steel bridges are seldom kept properly painted. Generally they are left until corrosion has progressed so far that the entire metal surface has to be sand blasted or scraped and every vestige of the old paint removed, then they are painted two or three coats of paint and forgotten for another period of five or ten years.

The examination of many truss bridges in all parts of the state has shown that with few exceptions the floor joists or stringers are weak, but the trusses are generally strong enough for the maximum load that can use a public highway without a special permit. This is probably due to the fact that engineers for a number of years have used a live load of 75 to 100 lbs. per sq. ft. of floor and sidewalks for computing truss stresses which are the loads still used, but the assummed moving load was very much lighter than the maximum loads of today.

We have found wooden floors carried on light 6-in. eye beams where the panel length was 16 ft. Of course such a floor is very elastic and there is a great deal of vibration when a load is passing over it. It was also customary to use a few wooden joists of the same depth as the eye beams for spiking the floor plank to, in place of spiking them to wooden pieces bolted

to the upper flange of the eye beams. In fact, that is still a common practice, although it is a very poor method as the wooden beams deflect more than the steel beams and cause the latter to act as a pry which loosens the spikes in the plank.

In many cases by the substitution of heavier stringers and a new floor, excessive vibration is eliminated and a new lease of life for the structure is secured at a comparatively small cost. Of course the dead load is increased but this is more than offset by the elimination of impact stresses which in the case of heavily loaded motor trucks is a very serious menace to the structure.

Another rather dangerous feature of most of the old bridges is the lack of wheel guards that offer any substantial resistance to a collision with the truss members. This danger is accentuated by the narrow roadway, which is seldom more than sufficient for two trucks to pass with careful steering, and also by sharp curves in the approaches which is so common a feature of those old bridges which for reasons of economy were nearly always built at a right angle to the stream.

While all modern bridges are designed to carry safely a definite maximum moving load, Massachusetts has no legal standard load for highway bridges; but a highway bridge carrying a street railway must receive the approval of the Department of Public Utilities, which has adopted certain rules and standards that are used generally by engineers in this state when designing both highway and railway bridges.

For suburban or heavy country highway bridges: For the floor and its supports, a uniform load of 100 lbs. per sq. ft., or a 20-ton auto truck having 6 tons on one axle and 14 tons on the other axle, the axles being 12 ft. apart and the distance between wheels 6 ft. This truck is assumed to occupy a floor space 32 ft. in length and 10 ft. in breadth. For trusses or girders, 80 lbs. per sq. ft. of floor surface for spans of 100 ft. or less, and 60 lbs. for spans of 200 ft. or more, with proportional allowance for intermediate spans.

Under the Massachusetts law, 14 tons is the maximum weight of vehicle and load that can use a public way without a written permit from the authorities in charge of the way. This law says nothing about bridges, but it is assumed that a bridge is a part of the road on which it is situated and is, therefore, included within the term "public way."

Other provisions of law, however, have apparently relieved a county, city or town, from any liability for damages resulting from loads that exceed 6 tons, including the weight of the vehicle.

The law also provides that notices may be posted on bridges stating the maximum weight of vehicle with load which the structure will safely carry. In the case of bridges on any earth, sand or gravel road, this maximum weight of vehicle with load is specifically fixed as 6 tons.

The difficulty with these laws in practice is that the notice rarely ever states the actual safe load, as in almost all cases the bridge will carry much heavier loads than that named in the notice.

The notice should state the actual maximum load the bridge can safely carry as determined from an inspection by a competent engineer, and any damage to the structure resulting from its use by a load heavier than that stated in the notice, should be recoverable in an action at law from the owner of the vehicle that causes the damage.

In this way many of the old bridges can be utilized safely and without serious inconvenience to traffic, until they can be rebuilt or replaced by modern structures, and excessive financial burdens will not be placed upon the county, city, town or state.

In other words, the equity in existing bridges should be utilized as far as it is consistent with safety, and a sound economic policy of replacement.

At present, the state is building only reinforced concrete bridges of the beam and slab type for spans up to 40 ft. in the clear, and the arch for spans over that length. The roadway is 26 ft. wide in the clear between wheel guards, and the fences are reinforced concrete of the post and panel type. The country bridges do not have sidewalks.

TILE DRAINAGE OF HIGHWAYS IN IOWA

By J. L. Parsons, County Engineer, Ft. Dodge, Iowa

That the drainage of roads is a fundamental requirement is generally recognized and needs no discussion. In general the policy of draining all graded roads, both county and primary, with lines of tile constructed on both sides of

the roadbed is the rule in the State of Iowa. In my territory, where land drainage has proven so beneficial, the complete drainage of roads as rapidly as possible is the one item of construction that has not been criticized.

In my opinion these two lines of tile should be constructed the entire length of a road that is being prepared for gravel or pavement surfacing, over the knoll as well as through the low places. If a sufficient number of inlets are constructed the passage of surface water in road ditches, or the formation of small ponds caused by obstructions, is largely prevented and the resulting saturation of the grade is reduced to a minimum.

The efficiency of this form of tile drainage is measured by soil stability and depends upon the physical composition of the soils in the roadbed. For convenience reference will be made to three classes of roadbed soils; sandy, surface and clay or close-grained soils. In the first case there is no question of the rapid movement of all excess soil waters laterally to the tile lines. This will prove true even though there is present only a small percentage of sand or gravel. In the second case where the top soil has not been removed in the construction of the grade, and where the material added in grading operations consists of top loam, drainage is generally facilitated by the numerous watercourses formed in the soil by plant growth and percolating water. It is in the third case that the danger signal is sounded. Difficulty arises because of the greater capillarity of the close grained soils. Such soils will draw water for distances as great as 8 ft. and often hold in excess of 50 per cent of water by weight. In many cases tile lines constructed in the side ditches will benefit these soils very little because of water bearing strata extending laterally or longtitudinally below or between the tile lines from which the sub-grade becomes saturated by capillarity. Once the sub-grade becomes saturated, whether by the retention of water on the surface or by capillarity, the road surface will soon pound to pieces under heavy travel. Sub-grades of this character may give little trouble during the warmer seasons and become quagmires during the spring thaws. Apparently this is a result of the expansion of the saturated soil during freezing and its consequent contraction when thawing out.

In Webster County in the spring of 1922 we experienced considerable difficulty with bottomless roads. In all cases excepting one the breaks occurred in cuts, where the top soils had been removed, and all of them on roads recently graded. Also in most cases tile lines had been constructed on both sides of the road. In an attempt to keep all lines of travel open on the main roads different expedients were tried. We had little success with gravel, but in several cases we were able to bridge the breaks by applying heavy coatings of cinders. One aggravated break was temporarily bridged by two lines of bridge plank. In several cases we employed adjacent farmers to pull unfortunates out of the mud until a remedy could be devised, the bills to be paid by the county. The most effective results were achieved by lateral tiling where outlets were available. Two emergency gangs were organized as soon as the frost could be broken by the use of picks and lateral tile lines constructed across the affected areas at approximately 20 ft. intervals. The tile were constructed at depths of 2 to 3 ft. The beneficial results were immediate and pronounced in all cases where this work was done. The permanent effectiveness of this method can be determined only after a more extended experience. My opinion is that in some cases it will be necessary to fill the tile trenches with gravel or cinders and to construct tile lines at still closer intervals.

The foregoing paper by Mr. Parsons was presented at the recent annual meeting of the Iowa Engineering Society.

WATER INFILTRATION IN SEWER SYSTEMS

By H. V. Pedersen, State Sanitary Engineer, Des Moines, Iowa

Excessive infiltration in Iowa sewer systems has given rise to certain problems for which few engineers have really taken time for working out a satisfactory solution. In years past it has been easy to say, "build the sewer lines tight so as to exclude all water or put in underdrains," but these theoretical proposals do not always prove practical. Those that have not given the matter much thought may wonder why there should be problems, but those towns of the State that have been compelled to install sewage treatment plants to dispose of their sewage properly and those engineers of the State who have had opportunities to visit and study various plants should not have a particle of doubt as to the troubles caused by excessive infiltration.

Out of the total number of 190 municipal sewage treatment plants in the State 122 are equipped with the shallow, Cameron type of tank. Many of these tanks are of just sufficient size to take care of the needs of the town. There are some exceptions where the plants are much too small and some where the tanks will be plenty large enough for years to come, but the great majority of Iowa plants are laboring, even in normal times, under the heavy load forced upon them. Every time it rains, and more especially in the spring, the water that finds its way into the sewer system through infiltration is excessive for the good operation of the plant and the tank tends to unload its contents out onto the filters where it causes ponding by reason of the surface mat.

Causes of Infiltration

This excessive infiltration may be due to several causes. (1) The contractor or plumber to whom the duty of construction has been given may fail to lay the pipe on a proper bed or cement the joints as specified by the engineer. (2) The contractor may do the work entirely according to specifications but the engineer has failed to judge the conditions of the various stratas and to provide for suitable construction. (3) It may be that at places all the precaution of both the contractor and engineer are of no avail and excess water finds its way through seemingly watertight joints into the sewer.

There is little excuse for the first cause. The contractor should be made to understand that if he did not make the sewer joints as tight as he could, or provide a safe foundation for the pipe he would not be paid for his work. Too many times have contractors gone along with construction, allowing their men to do inferior work and then make a big bluff at the end of the job. Men trained to lay pipe often are of such intelligence that they do not realize the troubles caused by infiltration and do not take pains and, in some cases, actually try to slip one over on the inspector. It is known that some men take great delight in cheating, just to boast about it later.

Then, too, keen competition in bidding often makes it impossible for the contractor to do good work and break even. Naturally a contractor wants to make money on the job. The town awards the job to the lowest bidder, makes the contractor slice and cut his bid in order to get the job and then expects first-class work. Competition is a good thing but all towns and all engineers must realize that a sewer job should be let at such a price as to allow the contractor to do first-class work and make a profit. If the engineer would see that a contractor gets a good price and then demands the very best job possible it is the opinion of the writer that 75% of the troubles of infiltration would be overcome at the start.

The second cause is often more difficult to determine and may, in a way, be more excusable. It is not possible to test every foot of a proposed sewer system and an engineer can only base his conclusions and draw up his specifications on what he knows. But even if a set of specifications may be protected by a suitable foundation clause it is often the fault of good judgment whether or not a certain grade of sand makes a good foundation. In a suburb of a certain city in Iowa a sewer system was recently constructed. The geological formation was such that a great deal of fine running sand was encountered. The contractor had bid a straight price on natural foundation and so much extra for every foot of made foundation. In order to save the city as much expense as possible the engineer in charge gave orders, in many cases, not to protect the pipe by laying it on a good prepared foundation, but to take a chance on the supposedly good natural sand foundation. At the final inspection it was learned that the pipe in many places contained much sand and water and upon investigation it was discovered that the pipe had settled to such an extent as to cause the joints to open enough to allow the fine sand to wash in.

There are very few places in Iowa where the ground is entirely free from sand veins and most of these sand veins contain great quantities of water. It is not practical to put in under-drains to take care of one or two sandy places and oftentimes it only takes one sand pocket to yield enough water to cause troubles at the sewage treatment plant. These special places are left entirely to the engineer in charge to overcome. A suitable foundation should be determined upon and special care should be taken to secure tight joints regardless of the rest of the system.

We now come to the third cause, which cause is the hardest to understand and overcome. It seems on first thought highly improbable that if both contractor and engineer take all the necessary precautions known that the sewer will still leak, but it is a sure fact. A sewer was

being laid up a rather steep hill in a certain sewer system in Iowa. The ground was a hard yellow clay with an occasional stone. As the trenching machine was just rounding the top of the hill it struck a sand vein and without a single moment's notice, the water began to wash in sand and dirt and before the men in the trench could act they were standing knee deep in water. It took a week to lay the pipe a distance of 20 ft. through this vein. The trench machine had to be abandoned and hand work adopted. Everything a man could think of was done to lay the tile to exclude the water, but upon final inspection it was learned that the pipe on this hill flowed one-fourth full of water in spite of all the precautions. The whole secret was that the water from the sand vein began to follow the pipe and although the joints were watertight at the sandy place it seeped through the crevices far below where less precaution had been taken to secure tight joints. In this case no one could blame the contractor and no one could blame the engineer. It was one of those places we too often forget to take into consideration when designing a sewage treatment plant to take care of excess infiltration.

There may be other reasons why water finds its way into a sewer. It is not my intention to point out all the various possibilities, my idea is to point out and to prove that although it is possible to control the amount of infiltration by good design and good construction, to a certain extent, it is not possible, under our present day methods of sewer construction, to exclude water entirely, if there is any water in the ground to get in.

Almost every engineer will admit that most sewer systems leak. The Iowa State Board of Health, through its rules and regulations, admits that most sewers will leak when it specifies that a system where the infiltration is not more than 1.6 gals. per linear foot per day for the entire system is considered good construction.

The theory is generally advanced that if a new sewer system leaks more than 1.6 gals. per foot at the final inspection, it will tend to tighten up as it grows older. This may be true and it may not. No doubt there is a tendency for some joints to fill with dirt and sand and some water is excluded, but there is very little proof that this is as great as we like to think. From the great amount of infiltration that has been observed in a number of old sewer systems in Iowa, during time of rain, it is the opinion of the writer that if a sewer leaks when it is first laid, it will always leak.

Too little attention is given to securing watertight joints, even today. Every once in a while some better informed citizen of a community rises up in indignation and makes life miserable for an engineer or contractor, but somehow or other everything quiets down after a little. Everyone seems to argue, "well, what difference does it make if a little extra water does get into the sewer? The sewer is large enough and can take care of it." I will admit that a little extra water from infiltration in a sewer which discharges directly into a stream does no particular harm, but I do say that extra water from infiltration in sewers where the sewage is treated does have many bad effects. Take for instance, in the spring of the year after a tank has gone all winter without cleaning. As long as it is cold no one wants to clean it out and it is neglected as long as possible. All of a sudden a warm day melts the snow or a heavy rain sets in which penetrates the ground and finds its way into a sewer. Now when most of our shallow septic tanks become full of sludge the detention period becomes less and less and in many cases even the slightest amount of extra water tends to create currents within them. These currents stir up the light sludge like particles which rise to the surface and pass on out to the filters where in less than a day's time it has rendered the filters incapable of filtration. When we stop to consider the great number of plants in Iowa that are actually put out of commission every year and require a big expenditure of money to put them in shape, isn't it worth while for us all to consider a few possible ways of overcoming the trouble?

There has been some talk of using cast iron pipe for sewer construction. This method would certainly reduce infiltration but whether or not the extra cost of construction would be worth the having less trouble at the treatment plant is a question I am not ready to discuss. It is certain that in some sandy places it would be well worth the engineer's time to consider whether or not the use of cast iron pipe would be cheapest in the long run.

Some use has recently been made of compounds in place of cement for filling joints. The first experiments of these did not prove very satisfactory, but the compounds on the market today seem to be giving satisfaction. Present day methods of making cement joints do not secure

watertight joints and if compounds are proving satisfactory they should be adopted by every engineer. It is certain that if compounds will prove durable and tight joints can be secured under all conditions that such methods of sewer construction should be universally adopted even if they cost from 10 cts. to 15 cts. per foot more than cement joints.

It has been observed that troubles from excess infiltration are more noticeable in the Cameron type of septic tank than in the Imhoff. Wherever a place is found where water is sure to be encountered the installation of a larger Imhoff tank, than would otherwise be needed, would be one way out of the difficulties. It has also been noticed that the deeper the Imhoff tank the less troubles are encountered. It is the opinion of the writer that more use should be made of the two-story tank and that the engineers refrain from installing the shallow type of tank, except where it is absolutely necessary to do so.

But, no matter what we might suggest as remedies for systems that are yet to be built, this does not relieve the troubles of the plants now in operation. Several of the plants in Iowa that have given trouble have been provided with a shut-off valve that governs a by-pass line. This may, on the face of it, seem to solve the trouble but when we stop to think that most of the plants are located outside of the town and that it often rains at night it is really absurd to believe that a caretaker will rush out to the plant and open the valve to relieve the tank at all hours.

In order to eliminate this human factor the best scheme yet devised to overcome the difficulties seems to be in the installation of an overflow weir. An adjustable weir should be so placed in a manhole, near the plant, that when the pipe flows above a certain height it will overflow into a by-pass line, thus relieving the treatment plant of excessive waters. It is far better to let some of the water escape directly into the stream at time of storm than to put the treatment plant out of commission trying to force it all through.

Sewage treatment plants are built to reduce the sewage of a community to a non-putrescible state. The fact that there are only 190 plants in the State does not mean that all the other communities will get by forever without one. It is predicted that many more treatment plants will be built in this state during the next 25 years, but just because a community is not contemplating the installation of a sewage treatment plant at this time is no sign that the pipe system should be poorly constructed. Sewer systems in Iowa are not built like they should be. The whole idea of the contractor seems to be that of throwing the pipe into the ground any old way and if the engineer attempts to force good construction he is immediately "black-balled" by the contractors.

It has been stated that many treatment plants in Iowa are suffering today because of excessive water of infiltration and I have pointed out a few causes of excessive infiltration. If this State is desirous to keep in the race of sanitary progress and keep its streams free from pollution we must urge many more towns to install sewage treatment plants, but if we are going to build high priced treatment plants, only to stand idle because they cannot be operated properly, I for one would advise against the building of treatment plants altogether. Engineers must either work toward designing plants so simple and so fool proof as to operate almost mechanically under all conditions, or improve in the design of the sewer line and house connections. Contractors must either be made to understand that it is important to exclude all unnecessary water from the sewer by laying the sewer pipe on a good foundation and then make every joint as tight as possible, or be prohibited from completing the job. Present day methods of constructing sewers in Iowa do not tend to secure watertight joints and it is the opinion of the writer that it is the engineer's duty so to mould public opinion as to make it possible to design and construct a sewer system in such a way that it will actually perform the work for which it is built.

The foregoing paper by Mr. Pedersen was presented at the recent annual meeting of the Iowa Engineering Society.

THE USE AND ABUSE OF HIGHWAYS

By T. J. Wasser, State Highway Engineer of New Jersey, State House, Trenton, N. J.

I wish to present what I have observed, investigated and studied for the past eight years, relative to the use and abuse of our highways.

It was in 1915, while I was County Engineer of Hudson County, New Jersey, that I first took up the subject with Wil-

liam L. Dill, Commissioner of Motor Vehicles of New Jersey, and stated that it was necessary to have additional legislation to protect the highways from the abuse brought upon them by commercial motor vehicles as they were being operated at that time.

The Commissioner immediately appointed a committee, of which the writer was made chairman, to investigate and report on the matter. This committee, after a year's work, submitted a report which was immediately incorporated into a legislative bill, introduced, passed and is at present a part of the New Jersey statutes.

My investigation and studies since that time, and more particularly during the year 1920 when I served as a member of the Motor Traffic Commission appointed by the Hon. Edward I. Edwards, Governor of New Jersey, have convinced me that, due to the growth and development of the motor industry, the fundamental principles involved in the financing, design, construction, maintenance and use of the highways no longer constitute a state proposition, but that it has become a national matter.

Much good work has been done by various individuals and organizations throughout the country looking toward this end. Literature has been published, and many articles written, but in nearly every case the author has presented the matter from his viewpoint alone, without giving consideration to the needs of others, and no concerted effort has been made, on broad lines, to bring the several interested parties together. The National Highway Traffic Association did attempt this; in fact it held a meeting in New York City, which I attended, and at which the several interests were represented. However, at the end of this meeting, the views expressed were just as far apart as they were before, and they are just as far apart today.

My experience in public life leads me to make the following statement: "There is a solution for every public problem if we eliminate the selfish interests involved," and I make that statement as applying to this problem.

Other attempts have been made to reach a satisfactory conclusion by conference, but without success, either in whole or in part. The pamphlet entitled "State Regulation of Motor Vehicle Common Carriers" issued in 1922 by the Motor Vehicle Conference Committee, affiliated with the National Automobile Chamber of Commerce of New York, cites the arguments presented for and against State control of common carriers. That is only one phase of the subject, and a final solution of it was not found by that committee, although state regulation of the automobile carrier is already well established in many jurisdictions.

President Harding's address to Congress under date of Dec. 8, 1922, treated this phase of the subject as follows:

Problem of Transportation

"Manifestly, we have need to begin on plans to co-ordinate all transportation facilities. We should more effectively connect up our rail lines with our carriers by sea. We ought to reap some benefit from the hundreds of millions expended on inland waterways, proving our capacity to utilize as well as expend. We ought to turn the motor truck into a railway feeder and distributor instead of a destroying competitor.

"It would be folly to ignore that we live in a motor age. The motor car reflects our standard of living and gauges the speed of our present day life. It long ago ran down simple living, and never halted to inquire about the prostrate figure which fell as its victim. With full recognition of motor-car transportation we must turn it to the most practical use. It cannot supersede the railway lines, no matter how generously we afford it highways out of the public treasury. If freight traffic by motor car was charged with its proper and proportionate share of highway construction, we should find much of it wasteful and more costly than like service by rail. Yet we have paralleled the railways, a most natural line of construction, and thereby taken away from the agency of expected service much of its profitable traffic, which the taxpayers have been providing the highways, whose cost of maintenance is not yet realized.

"The federal government has a right to inquire into the wisdom of this policy, because the national treasury is contributing largely to this highway construction. Costly highways ought to be made to serve as feeders rather than competitors of the railroads, and the motor truck should become a co-ordinate factor in our great distributing system."

The writer feels that the right to regulate against abuse of the highways, based on fundamental principles, should

also be taken into consideration in connection with the solution of the "Problem of Transportation." If this is a matter for Congress to decide let us present the facts at once.

"Highway" Defined

The writer has been using the term "Highway," and before making specific statements regarding the use and abuse of the highways, he desires to differentiate between the dictionary definition of the word "Highway" and the meaning of the word in this paper.

Funk and Wagnall's New Standard Dictionary of the English Language gives as the definition of "Highway":

(1). "A specific line of travel, by land or by water over which a right or easement is enjoyed by the public of freely passing; a public thoroughfare, as distinguished from a private way.

(2). In law, a generic name for all public ways, whether by legislation, dedication, or necessity.

(3). A main road as distingushed from branches and byways of minor usefulness.

(4). A common or open way or course."

In this paper, however, the term "Highway" will always refer to a graded roadway of a main public thoroughfare upon which is constructed a durable pavement of sufficient width and thickness to permit of two vehicles of the maximum size carrying the maximum loads permitted by law to pass each other safely and with sufficient clearance at the maximum legal speed.

Use of the Highways Prior to Completion

The highway during its period of construction is the greatest medium through which desirability of equipment, materials, products, and methods that enter into its construction are determined, and records properly and accurately kept during this period are of inestimable value for future consideration.

Experimental road work carried on by a state should be done in conjunction with the Federal Bureau of Public Roads, even though the work is financed wholly by the state. Such a procedure would eliminate much duplication of effort, would lead to the establishment of a uniform system of securing and recording information, and would provide for the dissemination of such data among the other states. It is especially desirable in the case of materials, methods and appliances controlled by their producers that conclusions, based on actual use on experimental sections, be digested and transmitted by the Bureau rather than by the agency having a commercial interest in the article.

Abuse of the Highways Prior to Completion

While highway construction is rated as the fifth industry of the United States there is a lack of co-operation among the several interests involved, with a resulting unnecessary added expense. This can best be corrected by recognizing the several component parts of the industry, and by standardizing as nearly as possible the products used and methods employed.

There should also be full recognition of the importance of the highway industry by the Interstate Commerce Commission and State Public Utility Commissions in the fixing of equitable freight rates on materials used in highway construction. Reasonable open top car service also should be provided at times when preference is given to carrying coal. The latter requires intelligent regulation in place of the drastic action that has been experienced in the past few years.

The greatest abuse often comes to a highway before it is built, namely, failure to provide adequate drainage, faulty judgment as to type and width of pavement, and choice of location to suit certain interests.

There are frequently abuses in connection with financing, design, and construction of our highways. Some of the more evident of these abuses are:

Making the term of bonds longer than the life of a pavement.

Failure on the part of the engineer to provide a design and type of construction to meet the requirements of modern traffic.

Faulty construction on the part of the contractor for personal profit.

Inefficient inspection due to lack of knowledge, and to insufficient salary being paid to attract capable men.

Acceptance of inferior work.

Permitting inferior material to be substituted for that specified when delays are brought about by conditions beyond the control of the contractor.

Sacrificing quality for speed.

Failure to provide for a satisfactory well marked and maintained detour during the period the highway is under construction.

Designing and building bridges for a

live load less than that for which motor vehicles are licensed and narrower than the graded width of the highway.

Failure to provide for the elimination of railroad grade crossings.

Designing underpasses with a head room less than 14 ft. in the clear.

Lack of co-operation on the part of public utility companies and municipalities. The highway departments should advise all interested utility companies and municipalities as soon as a highway project is decided upon, and these interested parties should immediately proceed to perform all necessary sub-surface work, thereby eliminating delay in the progress of construction and the necessity for opening the pavement in the near future.

Absence of caution on the part of bonding companies. Bonding companies becoming surety for inexperienced persons who are operating under the guise of contractors or construction companies jeopardize the interest of the State engaged in highway construction. They should limit the surety to a fixed amount for the first contract, increasing the surety on the second contract, and so on until the applicant establishes his responsibility for carrying out contracts of magnitude.

The tendency of contractors to bid too low. This fault has had more to do with the performance of inferior work than any one other cause, and inexperienced contractors just entering highway construction are chiefly responsible, yet the bonding companies will go on their surety just the same as they will for experienced contractors.

Use of inferior material. Competition in manufacturing or producing material used in construction is such that inferior material is frequently put in competition with satisfactory material, and by under selling is used in the work. In many cases where inferior material has been rejected by engineers and officials they have been charged with favoring some particular material or product for reasons other than its merits.

It has been definitely determined that excessive use of water in mixing injures the quality of concrete, yet in many cases engineers, contractors and inspectors still permit the use of excess water. The contractor permits it because his force can turn out more work, and he claims it just as good. The inspector tries to remedy matters, but is unsuccessful. The Chief Engineer can not see all the work, and a subordinate in carrying out his Chief's desires is accused of retarding the progress of the work. However, anything that tends to add unnecessary cost to the construction and maintenance of the highway should be considered an abuse just as much as should a violation of the provisions set down to protect it.

All these abuses should be corrected at once, and the industry protected by the soundest kind of financing, engineering design, faithful construction and efficient inspection.

The Use of the Highway After Completion

The use of the highway is very ably defined by quoting from the report of the War Department Claim Board in their reply to the State of New Jersey's claim on behalf of several of its counties, whose roads failed under the conditions exacted by the use of them by army transports during the War period, which reads as follows:

"With reference to your claim, and that of several counties in the State of New Jersey, for compensation covering repairs to roads which were used by government trucks traveling between the different munition plants and camps in said State, you were advised that this Board, after carefully reviewing all the evidence and circumstances in connection therewith, has denied the claim."

The following is taken from report of the Board:

"The roads, even though they were owned and maintained by the counties, were public roads and were open to lawful use by any individual or organization which desired to use them.

"If the power of a state to control its highways has not been delegated and the state has prescribed no conditions limiting or regulating the use of the highway, the people are at liberty to use it for travel, transportation, and communication subject to the condition that such right neither interferes with the lawful uses of the street nor invades the rights of the owners of abutting lands."

The Assistant Secretary of War has approved the findings and recommendations of this Board.

From the foregoing statement it is quite clear what is considered the use of highways. That the roads in question failed under army transport traffic is evidence that they were not designed nor constructed to withstand modern traffic.

Their failure should not be charged to abuse due to traffic, but should be charged to abuse by the governing body financing, designing, and constructing such roads.

At the present writing I am safe in saying that every state has many miles of such inadequately built roads, the upkeep and maintenance of which is out of all proportion to the service which they render. It is, therefore, necessary that only such highways as are efficiently financed, designed, constructed and maintained be offered to the public for use, in order that fundamental principles may be laid down that will make possible the establishment of regulations for the use of the highways.

Abuse of the Highways After Completion

Abuse of the highways is generally caused by a small percentage of users. Such abuse frequently results in accidents, causing injury and loss of life and destruction of property.

Law enforcement alone will not overcome these conditions or decrease the number of traffic accidents. The problem requires: first, adequate traffic planning, and second, proper enforcement of regulation according to the plan.

My deductions have been derived largely from observations of conditions in the more thickly congested sections of the country, and it is quite possible that some modification of my suggestions would be necessary to make them applicable to more sparsely settled communities. However, the fact must not be lost sight of that density of traffic increases rapidly with road improvement, and that provisions must be made for an unanticipated increase. Furthermore, right of way, grading, and major drainage improvements are practically permanent, and should be taken care of, once for all, in the original construction.

It is only necessary to observe the traffic conditions in any of our cities or upon our highways to appreciate the necessity of a wise and equitable policy of supervision. Such a policy must be drawn so as to prevent destruction of life and property.

In order to enable those whose duty it may become to work out an equitable and uniform plan to prevent the abuse of the highways, the writer recommends:

That the minimum graded width of all main highways be not less than 30 ft.

That this graded width be kept clear of all encroachments.

That all traffic rules be made uniform.

That a system of marking one-way streets be adopted, which will be uniform as to type and location of the markers.

That it is desirable to standardize all directionary and cautionary signs as to color and marking, and that posting signs other than directionary and cautionary on the right of way be made unlawful, and subject to a fine for each offense.

That the erection of signs on property abutting on the highway at curves, railroad crossings and intersections be discontinued, where such signs would obstruct the view of those using the highway.

That it is desirable to standardize colors to be used for degree of danger where illuminated signs are used, for instance, red at a railroad crossing or dead ends of highways, green for highway intersections, and amber for grades and curves.

That a uniform traffic regulation be adopted for intersecting highways to be in effect in the absence of traffic officers.

That a uniform maximum height, width, and length of vehicle be adopted.

That a uniform gross weight of vehicle and load for each class of commercial motor vehicle be established.

That all gas filling stations be located on property abutting on the highways, and not on the right of way; and that all gas filling stations shall display a visible tag on each pump, which shall be placed there by the State Department of Weights and Measures certifying as to the accuracy of said measuring device.

That parking of vehicles on both sides of a highway opposite each other, where a minimum distance of 20 ft. between the vehicles is not provided, be considered a nuisance and be made punishable by a fine.

That the erection of all booths and stands for the sale of goods within the right of way, and displaying farm produce in containers within the right of way be prohibited, and that the use of vehicles for retailing wares along the highway where such practice would cause persons to congregate on the paved portion be also prohibited.

That a uniform penalty for operating a defective motor vehicle on the highway should be provided. It is not the purpose of this paper, nor is the writer qualified to discuss automobile design; however, there is a common defect particularly in trucks, the correction of which would eliminate one source of danger. Tail lamps frequently fail to function due to

the wires having been damaged by abrasion or exposure to splashing water. It would seem to be an easy matter for the designer to provide protection for these wires. Other defects that the writer has in mind are broken or improperly adjusted brakes and badly worn tires.

That legislation be enacted to provide against motorists running past barricades on roads under construction, and destroying unfinished work.

That sidewalks be provided for the use of pedestrians along the highway adjacent to built up communities.

That pedestrians using the highways in the open country shall walk to the left, and that operators of all vehicles drive to the right.

That when one piece shipments that exceed the maximum weight allowed by law are made, they shall be shipped on specially built vehicles so designed as to distribute the load in a manner consistent with legal requirements, and only after obtaining permission from an authorized source.

That a uniform distinction be made between maintenance, betterment and reconstruction in order that comparisons may be made.

That motor vehicle taxation or license fees should not be any greater than that required to provide the sum necessary for maintenance of the highways.

That overloaded trucks being operated on the highways, when apprehended, be seized and held for a period of not less than five days, stored at the owner's risk and expense, and in addition the owner fined, in accordance with a penalty fixed for that offense.

That hauling companies, who contract for shipments by the ton, when caught overloading their vehicles, should have their license revoked, in addition to any other penalty.

That all operators of motor vehicles should be licensed, and that they be prohibited from operating a vehicle for more than twelve consecutive hours followed by eight hours' rest.

That, in addition to any uniform motor vehicle law previously recommended, all applicants for driver's license or renewal of same be required to submit a physician's certificate bearing date not more than one month back of the date of application. Certificate should be accepted only from designated physicians, and should certify that the applicant is in fit mental and physical condition to operate a motor vehicle.

That the examination for driver's license require the applicant to be able to read and write English, and that license be granted only to citizens of the United States with provisions for tourists from other countries.

That the owners of all motor vehicles must carry liability insurance for each vehicle operated.

That all vehicles, both motor and horse drawn, be equipped with a clearance light visible from front and rear. This light should be of a shape other than round, located on the extreme left side of the vehicle or load if over width, and showing green in front and red in rear.

Fundamental Principles

Fundamental principles are those which can be applied to the financing, design, construction, maintenance and use of the highways similarly in each and every state in the Union.

Financing Highways

It is the duty of the Governing Body charged with the financing of highways to provide funds for construction, either by bond issue or direct tax, using funds derived from the licensing of vehicles and drivers for maintenance only.

Design and Construction of Highways

The design and construction of the highway must first provide for a graded roadway properly and sufficiently drained and of a minimum width of 30 ft. Such a roadway should be free from sharp curves, steep grades, and all obstructions, including ditches, rocks, poles, fences, signs, drainage head walls, narrow bridges, trees, shrubbery, gas filling stations, etc.

The design and construction of the paved surface must be such as to meet the demand of regulated modern traffic. It must be of sufficient width to permit two vehicles of a size within the legal limits to pass each other at the legal rate of speed with safe clearance, and without danger of collision. In cases where such a width is not justified, it is recommended that half-width pavement be constructed with one edge on the ultimate center line rather than centering a narrow pavement on the graded way. Such an arrangement will best adapt itself to future widening, and in the meantime permits of the maintenance of an adjacent earth road. Local conditions will govern in the selection of the side to be paved, but as a rule it should be on the right hand side going towards market.

It must be of a type of construction to

permit carrying vehicles loaded within the specified legal limit, without injury to the pavement.

The construction of the highway depends upon the faithful performance, trained knowledge and ability of those engaged to carry out the provisions of the design.

Maintenance

The maintenance, in addition to upkeep, should provide for keeping the highway open for traffic, free and clear of all obstructions at all seasons of the year. Particular reference is made here to the care that is necessary to keep the shoulders adjoining the paved surface from being worn away. Excessive work on keeping up the shoulders flush with the pavement is due to insufficient width of paved surface, and should be charged to faulty design. The minimum width of the paved surface of a highway should be classed as a fundamental principle.

Maintenance should be of the highest order, in place of permitting the road to go to pieces for lack of attention to the drainage system and the ordinary wear and tear on the surface. Maintenance does not mean the restoration of a road that was faultily constructed or a well constructed road that was injured by overloaded vehicles.

If the principles set out are followed, then the highway is ready for use. If not, then I firmly believe the highway has been abused before it has been subjected to use.

Aside from the foregoing fundamental principles of the financing, design, construction and maintenance of the highways, the writer firmly believes that all the recommendations made by him to prevent the abuse of the highways, are fundamental principles for the regulation of the use of the highways, and that some action should be taken by this Association eventually to make them effective.

The foregoing is the text of the presidential address delivered by Mr. Wasser at the recent annual meeting of the American Road Builders' Association.

FIFTEEN MILLION PEOPLE LIVE IN ZONED CITIES

More than 15,000,000 people live in zoned cities, towns and villages, according to information made public recently by the Division of Building and Housing of the Department of Commerce. Computations show that the homes of 27 per cent of the total urban population of the country are located in zoned municipalities, and it follows that most of these homes are protected from intrusion of garages, stores, warehouses or manufacturing plants.

Zoning regulations provide, by a neighborly kind of agreement, that a city or town shall be divided into districts in which the uses for which structures may be built, their maximum height, and the area of the lot which they may cover, are established. In line with the zoning plan, certain districts are set aside for residences, for apartment houses, for office buildings, and for manufacturing. Ample provision is made for normal growth of business and industrial districts, but the builder of a garage or factory is not allowed to erect it within a residential neighborhood regardless of the annoyance and money losses inflicted on surrounding home owners.

The Department's investigation shows that in 1922 zoning spread especially rapidly in smaller places. Fourteen towns with five to ten thousand inhabitants were zoned during the year, bringing the total zoned towns in this class to twenty-three. Twelve places with 5,000 inhabitants or less were added to the list in 1922, bringing the total in that class to seventeen. The percentage of large cities which have already zoned remains much greater, of course, and of the 50 largest cities in the country, 22 have zoning ordinances in effect.

In the entire country, 109 cities, towns and villages were zoned January 1, 1923, as compared with 55 just one year before.

New York, the largest city in the country, has been zoned since 1916, and in contrast, the smallest zoned community had only 131 inhabitants according to the 1920 census. Eighty-one per cent of the urban population of New York state lives in zoned municipalities. California ranks second among the states with 71 per cent of her urban population zoned; Minnesota, third, with 58 per cent; New Jersey, fourth, with 57 per cent; and Utah, fifth, with 55 per cent. The entire District of Columbia is zoned.

In number of places zoned, New Jersey leads with 31; New York is second with 17; California, third, with 14; Illinois, fourth, with 10; Ohio, fifth, with 9; and Massachusetts and Wisconsin follow with six each.

The complete list of zoned municipal-

ities, as of Jan. 1, 1923, with references to the state acts under which zoning is permitted, may be obtained from the Division of Building and Housing of the Department of Commerce, which also has available for distribution such pamphlets as "A Zoning Primer," explaining in popular style the elements of zoning, and "A Standard State Zoning Enabling Act," a model act for the assistance of states in preparing laws permitting city zoning.

PREPARATION OF STONE AND GRAVEL FOR ROAD MAINTENANCE

By A. H. Hinkle, Superintendent of Maintenance, Indiana State Highway Commission, State House, Indianapolis, Ind.

(A) Gravel as used in road work might be classified as follows:

(1) Bank or Bar Run Gravel.

(2) Screened or Prepared Gravel.

(3) Crushed Gravel.

(1) *Bank or Bar Run Gravel* is so variable that the term means but little except in a particular job or as it applies to a particular bar or pit. Many pits or bars furnish native mixed material which is very satisfactory for use in gravel road work. Where bank gravel is intended to be used the specification should be made accordingly—the object of the specification being to secure the best grade of bank gravel which it is practical to secure in that particular locality. It is poor practice to specify a bank gravel and then draw a specification that cannot be met by any gravel in the neighborhood. Carelessness in writing a specification and then even greater carelessness in seeing that the specification is reasonably lived up to, has gotten many an engineer and contractor in trouble and occasionally the board of accounts is called in to "clear up the muss" and fix the responsibility for the specifications not being properly carried out. This carelessness in writing specifications and then the difficulty of getting them lived up to has encouraged, in some places, a specification which is in reality no specification at all. For instance, in one particular locality the only specification for gravel to be used in gravel roads and concrete work is, "It shall be a good cementing gravel." The specification might as well have said, "a good gravel" and stopped at that.

I will very frankly admit that it is not the easiest thing in the world to prepare a definite specification for each particular locality, which will secure the best local material which it is practical to secure. However, after sufficient study of the subject is made by the engineer, he can arrive at a proper specification. The State Highway Department of one of the states, just a few years ago, found it so difficult in attempting to apply the same specification to every community, that one of their representatives in explaining their troubles said that they finally became discouraged and threw away the specifications entirely and used such gravel as was available in each particular community.

The specification should be definite enough that a good contractor would ordinarily know whether bank run or prepared gravel would be required. If it is impracticable to secure the gravel specified, greater care should be taken thereafter in prepairing the specification. A practice which should be of assistance would consist in submitting to a laboratory, for a test, samples of the local gravels which it is believed would be satisfactory for the road work, and then prepare a specification according to this test which would permit these gravels to be used. In this way the poorer local gravels would be eliminated and the best local gravels allowed.

Owing to the small cost of the little equipment needed to make a screen test on gravel and the ease with which this test can be made, every county should be equipped to make this test. Quite frequently the governing factor will be the percentage of gravel which will pass ¼-in. circular opening or a No. 8 or No. 10 mesh sieve. With a little pair of scales and screen and two buckets, one can make this test in the field quite as well as in the laboratory.

The gravel banks and bars of Indiana, are almost universally found with an excess of sand. Owing to this fact quite frequently a roadbed can be built up of the local material, and thereafter the wearing course put on and replenished by using a better grade of gravel or stone from the commercial plants. In this way a properly sized and good quality of material is furnished as a wearing surface and a large initial cost saved by using the bulk of the cheaper material for a foundation which of course will not be as good as the better grade of material which might be shipped, but which may be as good as the traffic and finances available will justify using.

(2) *Screened or Prepared Gravel* is quite as variable in its make-up as is the

bank or bar run gravel. The product from any plant naturally depends upon the native supply and the degree of screening and washing that is done.

Dry screening is satisfactory to take out the over-size gravel but it is seldom satisfactory to take out the fine sand because of the difficulty of the fine screens clogging. Even the shaker and vibrator screens apparently are not proving satisfactory for dry screening gravel. While a dry screening plant will work in a very few exceedingly clean gravels where the sand and gravel particles are exceedingly hard and are almost totally free from clay and silt, such ideal conditions for its use are seldom found.

A washing plant whereby the silt and clay are removed from the gravel by streams or sprays of water and the gravel and sand sorted by screens aided by the flowing water, is usually the most practical method of cleaning and sorting gravel and sand.

To make clean aggregate for concrete the washing is a necessity in most plants. However, while the coating of the pebbles and sand grains with silt or clay is objectionable when same are to be used in concrete, it is not objectionable where the gravel is to be used in a gravel road. On the other hand it is a real advantage provided, of course, there is not an excess of the silt or clay. Hence if it were practical to secure the dry screened material for gravel roads, it would frequently be more desirable than the washed material.

Owing to the great variety of material that can be furnished by different gravel plants, it may be necessary to vary the specifications in cases to accommodate the product from the various plants. It is quite easy to say that a definite specification should be prepared and universally used. Although a certain specification may produce best results on the road, it may be economy in many cases to depart from this specification, if you are going to pay dearly for using it.

(3) *Crushed Gravel*: Prepared gravel made by crushing the over-size boulders in the gravel makes a product superior to uncrushed gravel for road maintenance purposes. The mixture of any amount of the crushed gravel with the uncrushed gravel aids it in compacting. A mixture of ½ crushed and ½ uncrushed gravel is quite frequently used and produces a very good material.

Specifications

(4) *Sizes*: The maximum sizes of gravel which it is desirable to use for various purposes may be listed as follows:

Sub-base course	6-in.
Base course	2½-in.
Top course (not less than 4-in. deep)	1½-in.
Future maintenance	1¼-in to 1-in.

If the gravel runs exceedingly fine as it usually does in the Indiana pits, a 1½-in. maximum size for maintenance may be used very satisfactorily; however, if the gravel runs coarse or crushed gravel is used, 1¼-in. or 1-in. should be the maximum size used for general maintenance purposes. Much trouble and annoyance has been caused by the use of too large a maximum size of aggregate in the maintenance of gravel roads. The large sizes do not permit the drag to smooth up the surface so well as when the finer sizes are used, and the surface is inclined to wear rough and uneven more rapidly with the coarse gravels in the surface.

The minimum sizes that might be used are preferably not to exceed 40% through ¼-in. and 10% through a No. 10 screen and 5% through a No. 30 screen; although gravels containing as high as 60% through a ¼-in., 18% through No. 10 and 8% through a No. 30 screen are used frequently with very good results. The most objectionable material is the excess of very fine sand and even material practically all passing the ¼-in. with not to exceed 18% through No. 10 and 8% through No. 30 screen, can be used as a skim coat in the maintenance of a gravel road with very fair results if the traffic is light. This brings us down almost to the sand-clay roads which give very fair results under light traffic, but which ravel quite badly during the dry season and cut up quite badly during the thaws, where heavy traffic comes on them.

It will thus be seen that the excess of very fine sand is the most objectionable part of many gravels and if this is controlled and the over-size gravel eliminated, we can allow a very large variation in the grading of the internal sizes and still get a very good gravel road. While a gradation of the gravel and sand grains from the largest to the smallest is desirable, especially where a heavy coat of gravel is placed, as this gradation makes a dense mixture and aids materially in compacting the gravel, yet this requirement may be sacrificed to a very large degree if we eliminate the over-size gravel and the excess fine sand, for these two latter requirements are the most essential.

It must ever be remembered that the expense which we are justified in creating in specifying a better and more expensive grade of material, depends upon the amount of traffic we are serving. Certain places in the State the local gravel is of such poor abrasion value that we find one yard of good gravel or stone which has to be shipped, is equal to two to three yards of local material, besides the better grade of material produces much less dust during the dry season and much less mud and slop during the thawing. Hence the use of the better material in these particular places, secures results which may far outweigh the additional cost where sufficient traffic is served. However, one should not be caught shipping material long distances and hauling at great expense to build a road when a local material practically as good may be found near by. A departure from this economic law in road maintenance has frequently started the taxpayers grumbling.

To determine which of such materials to use is one of the responsibilities of the road official whoever he may be. We will find much ground for a difference of opinion frequently, but if our knowledge is based upon sufficient observation and investigations, these opinions would not so frequently be at variance.

(*B*)—*Crushed Stone*: Crushed or broken stone has been used in the building and maintenance of roads for centuries. The method of its preparation might be classified as follows:

(1) Hand Broken.

(2) By Local (Small Portable) Crushers.

(3) By Large Commercial Plants.

(1) *Hand Broken Stone* for road surfaces and maintenance has almost entirely disappeared from use in this country. It is still quite extensively used in some of the foreign countries, especially the less civilized countries where the development of machinery has not progressed as in the United States. However, the hand breaking method is still used to some small extent in this State and in the hill portions of the country in general where small quantities of local stone are used for building and repairing light traveled roads. In such places shipping facilities are not available and it might not be economical to import a crusher owing to the small amount of stone that is used in any one place.

We have found it practical to use this method ourselves in a few cases in filling holes with local stone and in one case we have several miles of foundation stone which was broken with sledges after the stone was laid on the road. In new country where out-crops of good quality of limestone prevail at the roadside, this method no doubt will still be continued in use in building road foundations, as the large stone can be laid cheaply and only a very limited amount of sledging is required. Where limestone out-crops in the vicinity of the road and it becomes necessary to plug up breaks or mud holes in the road, I know of no more effective way to make a stable foundation hurriedly while the road is carrying traffic than by "sledging in" the large pieces of stone gathered from the field or local quarry. This coarse foundation stone must of course to be covered with fine stone, preferably of two sizes, the last coat not exceeding 1-in. in size.

Hand breaking caters more to the use of a coarser stone in the foundation which is exceedingly desirable, for if any great mistake has been made in modern road building to take care of the heavy traffic of today, it is in the use of too finely crushed stone for macadam foundation work. While hand breaking is a method of doing road work which in general belongs to past history, it is surprising to note how rapidly the process of breaking stone by hand can be done by an experienced bunch of laborers. Under special conditions such as these mentioned above, it will still be economical to use hand breaking in building foundations where it is not necessary to reduce the stone to a small size. However, for surfacing a road and maintenance work, the use of a modern stone crusher to prepare the stone is imperative.

(2) *Local (Small Portable) Crushers.* One of the advantages of the local or small portable crusher is that it can be transported to districts where out-crops of limestone are available and the stone crushed near the roadside and thus one of the expensive features of all road work, namely, that of the long haul, is reduced to a minimum. The disadvantages of the local crushers are (a) that it is more expensive to produce stone with a small crusher than with a large crusher; (b) It is difficult to produce the sizes that are frequently desired and the sizes that are absolutely necessary for certain classes of first-class macadam work. Of course it must be understood that the local crusher is only practical where suitable stone is found in the local com-

munity and an expensive haul or freight rate is saved.

As we build more and more the higher types of road, such as bituminous macadam and concrete roads, where the sizes of the aggregate are an extremely important feature of the work, the small portable crushing plants are not so suited for preparing the stone. They cannot sort and clean the stone so well as the large plants. I might cite as an illustration this past year where one of our contractors attempted to build a penetration road from stone prepared by a small local crusher located right along the side of the road. After spending most of the summer in attempting to secure the proper material from a small local crusher, he gave up in disgust late in the fall and shipped the remainder of the material from a large commercial plant at double the cost of what the local material was supposed to cost him.

However, if a sufficient sized crusher and proper screening plant is installed, any desired size and grading of stone can be produced from a portable outfit. We must weigh the cost, however, of such production, against the cost of the shipped material. With a local plant there is also only a limited demand for any one grade of stone and more difficulty will usually be experienced in disposing of the off sizes than from a commercial plant with shipping facilities, where there is a wider range of market.

(3) *Large Commercial Plants*: Inasmuch as the bulk of the stone we use is prepared at the large commercial plants, it is dealing with their output that we are mostly concerned. Large commercial stone plants should be equipped to produce any size of stone, and stone with any degree of freedom from dust.

Perhaps one of the defects in many plants is that they are not made so that they are sufficiently adjustable to different conditions, that is, so that they can shift from one size of grading of stone to another size without an expensive operation. This lack of adjustability in the plant is frequently caused by the lack of sufficient study and consideration being given the details of the operation of the machinery in designing the plant. It is best that the superintendent of every stone plant and the mechanic who may have direct charge of the designing of the machinery, should have emphasized to him, the importance of being able to shift from one grade of material to another when the demand of the output of the quarry makes it necessary, instead of resorting to the expensive method of storing stone or sometimes, as has been done, in shutting down the plant because all of the product of the quarry cannot be disposed of.

I one time happened upon a piece of macadam work where the specification provided that the maximum size of stone should go through a 4-in. circular opening. Some of the stone that arrived on the job was so large that it was quite evident that it had not gone through a 4-in. circular opening. I called by long distance 'phone the stone company's office and they assured me, after calling the plant and talking to their superintendent, that the stone was going through a 4-in. screen. I told them that I would be down to the plant that afternoon. After making a 60-mile drive across country and arriving at the stone company's office, I was told that they had made a further investigation and that it was possible that the screen was a 4½-in. screen. We drove to the plant, which is several miles out in the country, and after going up some 70 ft. in the air and looking at the screen in operation, the superintendent agreed that it might be a 5-in. screen. I prevailed upon him to shut down the plant so that we could meausre the size of holes whereupon we found that the screen was a standard 5½-in. screen and being an old screen badly worn in some places the openings in it measured as much as 5¾ ins. across. My experience on numerous occasions of this kind has led me to believe that too frequently the manager of a plant and even the superintendent does not give enough attention to the details of the screening, which is so important a feature of stone production in the preparation of stone for the building of the higher types of road.

Overloading of Screens: It is not uncommon to see stone coming from a screen with 20 to 50% of the material that would readily go through the openings in the screen over which it passes. This is usually due to the overloading of the screen. While the angle of the screen, size of openings and rate of revolution of a screen determines the amount of "fines" left in the product, yet every screen has a capacity, which, if exceeded, will greatly increase the amount of undersized stone left in the product. Sufficient screen capacity is just as important a part of the plant as crusher capacity.

Removal of Dust and Clay from Small

Size Stone: While use of the revolving circular screen is almost universal in stone producing plants, the separation of the dust from the finer sizes of material where it is imperative that those sizes be free and clean from dust, is now being done quite extensively by shaker and vibrator screens which perhaps clean the material better than by any other process. The ease with which the dust and fine material is removed from crushed stone depends very largely upon: (a) the percentage of clay that is permitted to go into the crusher and mix with the stone; (b) the moisture in the stone and clay; and (c) the hardness of the stone. It is very difficult to eliminate clay from the fine stone when it is damp as happens during a rain on the quarry, and when the clay has been put into the crusher with the stone. Where it is imperative to produce clean stone, as when the stone is used in concrete and bituminous roads, it is very imperative that great pains be used in stripping the quarry. During periods right after a rain if a little care is used in filling the cars in the quarry, frequently the freedom of the finer stone from clay will be very favorably affected. It is not uncommon to happen in a quarry after a rain in small plants where hand loading is done, and find the shovelers scooping up dirt, clay, stone and all into the small dump cars. One thing we can positively state is that if clay does not go into the crusher it will not come out in the fine stone. The harder and flintier stones naturally produce a cleaner, small size product than the softer stones.

Sizes of Aggregate for Various Purposes: There is such a large variety of sizes of aggregate used for various purposes, that it would almost make one dizzy to enumerate all of them. For this reason a number of years ago an attempt was made to standardize on the size of aggregates. This was done fairly satisfactorily. However, it seems that owing to the fact that difference in various city, county and state specifications and the different ideas of various stone crushing companies as to what size they should make, has caused us not to make much progress in this standardization of sizes. It is a fact, too, however, which must be taken into consideration, that stones of different hardness will permit the use of a little different size; that is, generally speaking, in macadam work the harder the stone the smaller should be the maximum size used for any particular purpose.

A general principle in the sizing of stone for macadam work might be to use as coarse a stone as can be used without causing an objectionable roughness of the particular type of surface in which the stone is used. The thickness of the surface course may determine the maximum size that can be used; that is, within certain limits a thin course will require the use of smaller size stone than a thick course. As a general guide the following might be taken as a limitation of sizes for various purposes:

Waterbound Macadam Top Course

(a) If surface is to be maintained in the future by the applying of fine stone and dragging, 1½-in. to ¾-in. size.

(b) If surface is to be maintained in the future with the use of bituminous surface treatments, 3½-in. to 2½-in. 1-in. to dust for soft stone.

(c) For filler ¾-in to dust for medium stone; ½-in. to dust for very hard stone.

Bituminous Macadam

(a) Covering stone for first application of tar or asphalt, 1¼-in. to ¾-in. size.

(b) Covering stone for last application of tar or asphalt, ¾-in. to ¼-in. size.

Bituminous Surface Treatments of Tar or Asphalt

(a) Treatments ⅛-gal. per square yard, ½-in. to ⅛-in. size.

(b) Treatments ¼-gal. per square yard, ¾-in. to ¼-in. size.

(c) Treatments 2-5-gal. per square yard, 1-in. to ½-in. size.

Stone Road maintained with light covering of stone and dragging operations:

(a) Very light application of stone—Hard stone, ¾-in. to ¼-in. size; medium, 1-in. to ¼-in. size; soft stone, 1¼-in. to ¼-in. size.

(b) Heavy application of stone—1½-in. maximum size may be used, preferably to be covered with one of the above sizes.

Cold Bituminous Mix for Patching

(a) To be put down with a roller or under very heavy traffic, 1½-in. to ¼-in.

(b) To be put down by hand tamping, ¾-in. to ¼-in.

While the above tabulated sizes are more or less the ideal sizes, quite a variation from these can be permitted in some cases, and yet first-class results be secured. In fact there may be certain

conditions where a departure from these sizes would be desired. For instance: Where a comparatively soft stone is used in bituminous and waterbound macadam to be later maintained by surface treatment, the larger size stone might better be a maximum size that will go through a 4-in. circular opening instead of a 3½-in.

While for foundation stone, in order to accommodate the quarry, frequently 2-in. or smaller stone has been used, it undoubtedly would be better to use a much coarser stone, even as large as would go through a 6-in. opening, if the stone is to be rolled and waterbound.

(C)—Wise Location of Gravel and Stone Plants Necessary

Proper selection of quarry sites and location of gravel plants both for the local plants and large commercial plants, is very important. Before capital is invested in such a plant, the gravel and stone should be tested for all depths and areas over which it is contemplated to develop the plant. Capital cannot be wisely invested unless this is done. Too frequently a quarry or gravel plant has been located only because it was considered an economical place to strip the stone or gravel. The saving in this respect in a particular location may be only a very small part of the cost of production which small saving might have been counteracted several times by the better quality of stone or gravel at some other location. One thing is certain, that if the quality of stone or gravel is not present to start with, a good product cannot be produced. In many places a plant would not have been opened up at all had sufficient examination been made. A plant that can economically produce good gravel or good stone is an asset to the state and the taxpayers profit thereby. A plant that produces poor grade material and does not operate economically is a disturbing factor to good society. A poor grade stone can frequently be produced cheaper per ton, than a good hard stone. This cheaper cost of production is too frequently used in maintaining a big lobby to force the sale of the poorer grade material to the road officials. In such cases the road official needs our sympathy. Here is where a laboratory test on the material may come to your relief. The good material sells itself and only necessitates a large promotional expense when the other fellow gets the best of the situation. Let us hope that everything possible will be done to overcome the over-promotion of poorer grades of material and material that is not economical to use. We can assist in this somewhat by being fair to the legitimate commercial plants which produce good material. Much capital is invested in them. They are an asset to the state and should be encouraged. We should not encourage the establishment of local plants because these can produce material about as cheaply on the road. The local plants should be encouraged only when beyond a doubt they can produce material on the road cheaper than the commercial plants, taking into consideration the quality of the material. The commercial plants have been hit an awful blow the past few years because of the unstable situation of our railroads and some of them will need nursing if they survive another similar condition. However, the economic law of production of road materials must prevail and if this fluctuating condition of our railroads is to continue in the future, the shipping of road material will have to harmonize with it.

(D)—Talent Needed in Manufacture of Road Materials

Although the road material producers, and we in the road maintenance and construction work, may feel too proud and bigoted to admit our work is not being done to the maximum efficiency, we will have to admit as part truth the statement some one has made, namely, "The brains of the world is now employed in the automotive industry!" This industry has paid bigger salaries and has offered greater inducement to our young men than the road work. Let us hope that we may stem the tide eventually, and direct back into the channels of road production some of the talent that has been going into the automotive industry. The advance that this industry has made over road production is too great. The road work should keep abreast, if not a few years ahead, of the industry which wears out the roads. The public must be made to see the truth. It is not consistent that an automobile owner should pay 12 cts. for operation expense for every mile he drives his car, and then object to paying 2 cts. gasoline tax which on an average amounts to 1-6 cts. per mile, in order to have good roads over which to operate the car. Any man who continues to study any subject and has a reasonable education, eventually becomes more or less of an expert in that subject. Cer-

tainly with more talent directed into the production of road materials, and doing road maintenance and road construction work the industry would be benefited.

The foregoing paper by Mr. Hinkle was read at the Purdue Road School, Jan. 23, 1923.

THE RESUSCITATION OF A WATER COMPANY

By Farley Gannett, of Gannett, Seelye & Fleming, Inc., 1 N. Market Square, Harrisburg, Pa.

A human being, when immersed in water, dies for want of air. This is a story about a water company, which nearly died for want of water when its reservoir would hold nothing but air. It was resuscitated by giving it water in its reservoir and forcing water out of its capitalization. It wouldn't have done any good to attempt filling the empty and leaking reservoir with water squeezed out of the capital stock as it wasn't the right kind of water.

The story, although essentially an engineering and financial one, has running through it a strain of humor, courage, trouble and romance, as most stories of this kind must have when all is told. Many years ago two young men, who later became famous in Pennsylvania history and politics, travelled through the rough and rugged hills of Cambria County, in Central Pennsylvania, on horseback, as there was then no other means of travel, looking for signs of the coal deposits which it was rumored were to be found in that region. They finally found what they sought, but it was far from railroads and there was no means of getting the coal to market if they mined it. The hardest task before them was to convince the distant railroad company of the value of the coal lands, and to induce the company to run a track to the coal field. This was finally accomplished, but how the result was brought about is another story.

The mine was opened and a village sprang up and grew about the mine. This village is now the Borough of Spangler, sprawled over about two miles of landscape in a narrow valley at the head waters of the Susquehanna River. It is so high up in the mountains that the streams thereabouts are all very small except the main creek in the valley, but that, due to mine water drainage and mine village drainage is not fit, and could not be made fit, to use for drinking water.

It soon became necessary to supply the village with water and these two partners, who were still young and struggling, and who had induced others to join in their coal development, decided to build a water works system to supply the town. Their associates joined with them, the village streets were piped and connected with a reservoir which was built about a mile from town. The water collected behind the dam, flowed through the pipes and into the miners' houses, stores, hotels and livery stables, and a little into the many saloons, and all went merrily as there was no pumping to be done and all the owners had to do was collect the revenues.

The water works business looked fine to these men who had been working so hard to make ends meet in the coal mining and as the town grew more houses connected to the pipe lines and the receipts increased, and there were no corresponding increases in the operating expenses. The partners looked at each other and said they wished the whole world was just one great water works system and belonged to them.

This story wouldn't be a bit interesting, if it stopped here. It certainly didn't because one fine day when one of the partners turned on the spigot in his house nothing but air came out. He jumped on his horse and rode to the reservoir and found it empty, where the day before it had been full. Where had the water gone? It was soon found that it had gone through the bottom of the reservoir into a coal mine. Another source of water had to be found. That is a short sentence and a simple one, but its meaning was portentous to these men. Water was scarce, and it costs a great deal of money to build reservoirs and pipe lines. There were coal workings under the nearby streams and they would have to go some distance to find a stream that was not underlaid by coal.

Finally one was found, where the coal was so far below the surface as to make it safe to build a reservoir, Brown's Run, by name, some 2½ miles distant and high enough so as to enable the continuance of the gravity system of supply, but it would cost $40,000 to build the reservoir and long pipe line and the stockholders of the water company were looking for money to come in and not go out. The town was without water, and the company had obtained a state charter which obligated it to supply the town. The people had built houses there depending on

the water supply and looked to their employers, who owned the water company, to furnish it to them. There was nothing to be done but to raise the money and build the new dam, so with fear and trembling the two friends approached their associates with the proposition and when the situation was explained the money was raised, but not without objections, hesitation and even flat refusal from some.

The dam was built, far larger than the former one, to store sufficient water to last the town for half a year even during a severe drought. The pipe line was 12 in. in diameter, compared with the old 6-in. line to the first reservoir. It was all built for about what it was expected to cost. The water was clear, pure and soft and out of danger of coal mine workings, and all was ready to run merrily again. But, when the valve in the pipe through the dam was closed to allow of the reservoir filling up, a small trickle of water appeared below the dam at one end, coming through underneath, and as the water rose in the reservoir this trickle became a stream, until the outflow equalled the inflow and the reservoir stood only about one quarter full. As soon as a dry spell occurred this water was used up and the natural flow of the small stream was so slight that the town didn't have sufficient water, so the only thing to do was to spend some more money and try to stop the leak. Grout was pumped into the underlying rock to no advantage and other means were tried, engineers made reports and explorations to no avail; still the water poured through under one end of the dam in undiminished volume and most every summer the town was dry. The railroad company, which had gladly contracted with the water company to use this pure soft water for its engines, had to go back to polluted, acid-laden creek water and the owners of the water company who lived in Spangler had their lives made miserable by complaints of lack of water all over town as soon as it stopped raining or whenever the sun shone for a few days in succession. The company didn't dare to take on new business and the consumers demanded and had to be given rebates when the water was short. It began to look serious, the company had issued bonds and couldn't pay the interest and of course had not paid dividends on the stock. Money to the extent of many thousands of dollars had been borrowed from the local bank to keep the property alive and there was no hope of paying the money back for it cost more to run the plant than was received in revenues. Everyone complained, consumers, bondholders, stockholders, banks and officers. Something had to be done, but what, no one knew. It looked as if the dam couldn't be made to hold water and there was no more money to be obtained for a new dam, but things couldn't go on as they were going.

Now, this is where the true story begins, the preceding introduction is word of mouth history, pieced together from fragments obtained from harassed officers, disgruntled bond and stockbrokers, angry consumers and the like. The archives of the State added other facts.

One day the president of the water company came into our office with the treasurer, and said they had a leaky dam that needed fixing. They had heard something to the effect that we thought we were good at that kind of thing. We admitted we were all that and would be glad to fix up their little old dam some Sunday when we were not very busy. We didn't know as much about that Brown's Run dam as we know now. We didn't know how many people had tried to fix it and we didn't know that the whole side hill at one end of the dam was a mass of rotten rock and that way down deep under the solid rock were holes big enough for a man to crawl through.

We examined the dam and obtained all the data we could, watched the water coming through the dam and thought we knew how to solve the problem. It looked comparatively easy. We had a meeting with several of the officers and directors and learned of the financial position of the company. Owing to the trials and tribulations which had been encountered, bonds, stock and notes in bank had piled up to such a figure that the company couldn't hope to add to it and continue the struggle with such a load on its back, even if the dam was repaired and made to hold water.

A plan was worked out by which these securities were reduced to reasonable proportions and the owners thereof agreed. Then a new first mortgage was placed on the property and as the estimated cost of repairs and improvements was $25,000, that amount of bonds was authorized to be sold. We then made a valuation of the plant and found that the rates were too low and decided to raise them 50 per cent! And to cap the climax, we decided to sell most of the bonds to the water consumers. That showed

some courage, you will say, gentle reader, and echo says it did.

The original partners, or their heirs, agreed to buy some of the bonds, and we did too, to show our confidence in the proposed method of repairing the dam. The rest of the bonds were actually sold to the consumers in $50 to $500 lots and the money was all raised. The reason why the consumers bought the bonds was that they hoped, as a result of this new money, to have an ample and continuous supply of water and they didn't object to the raise in rates because that insured the payment of the bond interest and nearly every consumer or his brother or friend bought a bond.

Then we started work on the dam. We emptied the reservoir, supplying the town with what was available in the stream, augmented by water pumped from a well once used by a brewery in the town. Then a trench was excavated near the upstream toe of the slope on the end of the dam under which the leak occurred. This trench was about 70 ft. long, and about 10 ft. below the level of the original ground we found rock for some distance in the trench bottom, but this rock suddenly stopped on a sharp fault line, the bottom turning into a dense yellow clay. This we concluded didn't leak and so devoted attention to cutting down into the rock until we found where the water was coming through. This rock was of an unusual nature in that for a considerable depth it would appear to be solid, undisturbed red sandstone lying nearly horizontal, and then on penetrating to a greater depth in this solid rock, we would find rotten, crevised rock below with large openings through it, through which the water was leaking. At a depth of some 30 ft. we encountered a large opening of this character and satisfied ourselves that this was the channel by which the water leaked out.

We backfilled the entire trench with good clay, borrowed from the hillside above the dam, puddled it well, closed the valve and waited for the water to rise. We had spent less than one-half of the money raised by bonds and were vastly pleased and satisfied, and again things were about to go merrily. But the water rose and the leak again appeared, not quite so great, but still too great to be permitted and too great to allow of supplying the town from the reservoir. We decided that the water was now coming under the extreme end of the dam toward the north hillside so we reopened the trench and uncovered the rock and continued northward to the very end of the dam where the crest meets the hillside. We went through layer after layer of good solid rock with rotten rock between, until we again found a large fissure and traced the reservoir water through it and out into the channel the leaking water had worn below the dam. Again we congratulated ourselves that we had discovered the source of the trouble and we backfilled with clay puddle and sat back to see the water rise in the reservoir and stay there, but it didn't stay there. It rose until the reservoir was about one-third full and then began to leak. Then came a heavy rain and the reservoir rose to about 20 ft. depth, to within 5 ft. of the spillway, and not only did the old leak increase, but a new one appeared on the other end of the dam under the spillway!

We still had about $5,000 of the bond money left, but it was late in the fall by this time and we decided to wait until the next spring before going at the leaks again. During the winter and spring there was plenty of rain and snow to keep the town supplied and by starting work early in April it was expected to have the leak stopped and the trench backfilled before dry weather set in, so the reservoir would fill.

So early in April the trench was again opened and extended into the hillside as it seemed certain that the water was going into the hill and around the end of the dam.

An order had previously been issued by the State that the spillway on the dam would have to be enlarged, if the leak was to be stopped. The State apparently admitted that as long as the reservoir couldn't be filled with anything but air, the spillway was large enough and paid us the compliment of anticipating that we would finally stop the leak, in which event the authorities planned another way for the expenditure of money the company didn't have and couldn't get. Nevertheless do it the company must, so we started that job, too, and also cut down the spillway to excavate a trench to be backfilled with clay puddle to stop the leak that appeared there last fall. With all of this work going on, and bond interest and note interest to meet, and a little less confidence in the ultimate outcome, the future wasn't quite so rosy.

But don't forget we had increased the rates 50 per cent and also, in anticipation of having plenty of water, pipe lines were laid in unpiped streets of the town and

quite a number of new consumers had been taken on, so the revenues were nearly twice what they were before. This helped out on the new work and we plugged ahead.

By this time I was afraid to meet the two partners, officers and directors of the company because of the sad and reproachful looks they always gave me, and that wasn't all they gave me sometimes, but don't think our troubles were over, or nearly so, the worst was yet to come.

For a third time a channel was found far down in the rock and for a third time water was seen coursing through it and was traced to the channel below the dam, and for a third time we cheered ourselves with the belief that our troubles were over and for a third time, and this time with great confidence the trench was puddled with backfill, and for a third time the valve was closed. We waited for rain to fill the reservoir. It came and some of it went right through under or around, or over, or through, or somewhere, but at any rate it appeared in the same old channel below the dam, but in still more reduced quantity. It did not rise high enough, however, for us to tell whether the leak under the spillway on the other end of the dam had been stopped or not.

The weirs, however, told us that for the same height of water in the reservoir the leakage was less than one third what it was originally and that with the reservoir full we could expect it would be no greater than enough to supply the town. The head from a point just below the dam was sufficient to give ample pressure to all parts of the town, so we conceived the idea of conserving this leakage in a small dam below the main one and abandoning any further attempt to cut off the water passing under or around the main dam.

We designed a small intake dam 7 ft. high and holding about a day's supply, with a feeder pipe to the supply line from it and estimated its cost and put the plan up to our partners, the officers of the water company. More money to spend—we told them it was the only hope and the only sure way to save the situation and that to cure the main dam of its ills we might have to go back a mile into the hill, etc. So they finally agreed.

We had already found that the company didn't own quite all the land necessary for this little dam, but as only two acres were necessary and as the land was brush covered waste land, unused and practically valueless, we were sure it could be bought for a song. The owners, a family of foreigners, were approached but they had already discovered our situation and saw why we needed their land and generously asked $1,500 for the two acres, worth $25 an acre. Ordinarily this offer would have been refused and the land condemned, but the State of Pennsylvania years ago decided that water companies were grabbers and trusts and altogether not to be trusted and the right of eminent domain was taken from them, so we had to negotiate with the owners and finally paid $700 for this little piece of land vitally necessary to us, but nearly valueless to the owners. Then we built our new intake dam and were again ready to have things go merrily.

Everyone has heard of the great drought which struck the East and particularly central and western Pennsylvania last summer. Well, it struck poor little Spangler and struck hard. It didn't rain any to speak of for six months from July, when the new dam was finished, until December. There were traces, and once in a while a thunder storm, but that was all. No water gathered in the reservoir and the stream, Brown's Run, dried and dried and dried, until the weirs warped in the hot sun.

Of course, there was no water to supply the town and the well we used the year before was again brought into service, but droughts affect wells too and in a few days it was pumped dry. The main creek in the valley was exceedingly low and thick with acid and other pollution, so it couldn't be used. In the meantime, with the weather hot and dry there was actually no water in the system and no place to get it apparently. Water had to be obtained somewhere, somehow, and investigation was made of every damp spot in the neighborhood. The matter finally resolved itself down to using water which was being pumped out of a nearby mine, and this we proceeded to do. An electrically operated pump was installed and connected by a pipe line, laid on the surface of the ground to the distribution piping system, and we had water, but such water. It was wet and had no bacteria in it. They couldn't have lived in it. All this only took about three days.

Of course, people didn't like this water, but they were glad to get anything and everybody in town or his neighbor or his brother, or brother-in-law owned bonds and so no complaints were filed. The State permitted the use of this water as it contained no disease germs.

Well, this went on for two months, with a little sprinkle of rain each month so that the pipes could be filled a day or two a month with good water, until all of a sudden the mine we were getting the water from blew up. The whole country heard of the explosion in the Reilly Coal Mine at Spangler last fall when 83 miners were killed. Well, that was the mine we were getting water from and our pump and pipe line and everything was blown in all directions.

Then, the first stroke of good fortune befell this little corporation—it rained all one whole day and for two days when the hospital was full of injured and the town was full of sadness and grief, the water pipes bulged with an ample supply of good pure mountain water and during this time the pump and pipe line and electric power line were repaired and when the rain stopped and the stream dried up, the mine water was again put to use.

About Christmas time rain and melting snow began to fill the reservoir, then more rain and more melting snow came, the mine supply was shut off, the pump dismantled and the reservoir filled gradually. The new intake reservoir was put into service and now the main reservoir is nearly full, more than it ever had in it before. The leakage is less than the daily needs of the town, and all goes merrily once more.

The bond interest has been paid, the supply now is assured, the reservoir is sure to fill this spring, and if it never rains all summer and fall this year, we will start with a full reservoir and can take care of everyone.

This is the end of the story—we hope.

WINTER ROAD WORK

By John H. Mullen, Chief Engineer, Minnesota Highway Department, 1216 University Ave., St. Paul, Minn.

The attention of road officials may well be directed to the problem of extending their work over the winter months, for road work is generally conducted as a seasonal activity and there is a period in the winter during which construction organizations and equipment are idle and for this period of idleness there is a loss, not only in progress of work, but also in the efficiency of the working forces, as well as in the cost of overhead and investment on equipment, which must be compensated for in the cost of work done during the summer months.

Paying for Lost Time.

Road building has become a business, engaging the attention of business men, and we would not delude ourselves with the idea that we are not paying for the time of the contractor and his principal assistants while idle, nor for the interest on his investment in equipment when not in use, for the road contractor, like other business men, is applying cost accounting and business methods to his work, or will have to if he continues to operate, and the public will pay the bill. Accordingly, any means whereby the fixed overhead and equipment charges can be spread over the whole year instead of being carried by a few months' work will be a direct saving to the taxpayer. This is the economic, engineering side of the question. Then there is the other phase, quite important, too, of providing winter employment for a part of the large army of men engaged in road work during the summer. True in some parts of the country there is still the opportunity for men and teams to obtain employment in the winter on such work as logging, but this work is diminishing and is also becoming an all-year operation which does not offer the chance for winter work to men from other lines, so that we have the further responsibility of taking care of unemployment, or be faced with the proposition of paying wages sufficient to carry men through the winter, for men must live and teams must be fed in the winter as well as the summer.

Minnesota Experience

The nature of road work makes the problem seem rather difficult, but our experience in Minnesota is that the situation can be greatly improved by planning our program of work well in advance. This applies particularly to grading, for every year we have a number of projects on which there is rock excavation, or heavy earth work, with deep cuts and large enough quantities to warrant the use of steam shovel equipment, which can operate on that work as well in the winter as in the summer. We find that if contracts for this kind of work are let in the fall, the contractor is thereby enabled to make use of steam shovel equipment to advantage during the winter, and can then hold a nucleus of his organization together through the winter, and also benefit by the lower wage scale prevailing at that time. This all makes for a lower unit cost of excavation and has the further advantage of

disposing of the heavy work in advance of the ordinary grading operation.

Examples of Grading.

An example of this kind of work is a last winter's job 5.1 miles in length, involving 172,600 cu. yds. of excavation, of which 110,167 yds. was rock, which was done at a price of 19 cts. for earth, 65 cts. for loose rock, and $1.30 for solid rock. Winter work cannot be credited entirely with these low figures, for the work was very heavy, averaging nearly 34,000 cu. yds. per mile, and the rock was a soft limestone, but attention is called to this job as being especially suitable for winter work. Another project is a 40-mile piece of grading on new location, now being done, on which the estimated quantities are 418,000 cu. yds. of earth and 130,000 cu. yds. of solid rock, which was let at a price of 45 cts. for earth and from 95 cts. to $1.60 per yd. for rock. This is in a timbered country, rather inaccessible, and the prices on this work are low when it is considered that there is no loose rock classification and the solid rock is a tough granite or trap rock. The variation in rock prices on this job is due to the fact that some of the rock excavation is along the bluffs on the shore of Lake Superior, which allows for side casting without any haul, and is being done at a price of 95 cts per yard while the rock work involving haul costs $1.60. Letting this work in the fall also allowed for all of the clearing on the line, about 316 acres, to be done in the early winter. On the whole, we believe that such conditions as existed on the two projects referred to and which prevail in a measure on a good percentage of our work, can be handled in the winter, or as combined winter and summer projects, to the advantage of all concerned.

Gravel Surfacing

In the northern states most of the roads are being improved by gravel surfacing. Taking again, as an example, the state of Minnesota, we find that in the past two years there were 1,675 miles of this kind of work done by the state alone, with an average of 1,500 cu. yds. of gravel per mile, or a total of about 2,512,500 cu. yds. of gravel hauled. In addition to this there were 1,750,000 yds. hauled by the counties on secondary roads. Of course, a portion of this had to be done in the summer time on account of wet pits and the necessity for shipping in cars, but we have found that a great deal of this material could be hauled most economically in the winter time, especially when long hauls were involved. This is due in part to the lower labor rates, but is principally due to the fact that when the roads are frozen smooth, and we make it our business to see that they go into the winter in that condition, the trucks or wagons, as the case may be, have the benefit of a surface to haul over that is as good as a concrete road, which permits of a maximum loading and consequently a lower unit hauling cost. As an example, last winter one contractor with a fleet of 26 trucks hauled 28,000 cu. yds. of gravel an average of 9 miles in 25 days. The contract price for this work was 20 cts. per cu. yd. mile, and the average truck load was 7 cu. yds. This would have been impossible in the summer time, not only because the contractor could not have hauled so cheaply over earth and gravel roads in the summer, but because we would not allow such equipment to be used on account of the damage or destruction of roads being hauled over. Summer gravel hauling is restricted for this very reason to pneumatic tired trucks, which of course, limits the loads to about 3 yds. In the past winter, Minnesota contracted 1,350,000 cu. yd.-miles of gravel hauling by truck at an average cost of 22 cts per yard mile. This compares favorably with the average cost of 27 cts. per yard mile for summer haul.

Team Hauling

Winter graveling is not by any means confined to truck hauling. Perhaps the greatest benefit of this work to unemployed has been where the material has been hauled by teams. A striking example of this is our experience last winter in a section of the State where farming and financial conditions had made it very difficult for some of the people to get through the winter. It so happened in that territory that a large mileage of grade was ready for surfacing and dry pits were available. Accordingly all the men and teams that could be used to advantage were put to work as an emergency measure and in all about 500,000 cu. yd.-miles of gravel were hauled at an average cost of 20 cts. per yd.-mile. This cost is low for team haul, but the team owners were anxious to have the work and were willing to work long hours to obtain the money so made available; in fact, while the engineers were able to place 340 teams on this work there was probably about one-third as many more who would like to have had the same opportunity. It is needless to say that this operation was of financial advantage to

the State as well as a means of taking care of a serious unemployment situation. Gravel hauled in the winter is generally deposited in continuous "windrows" on the grade, and is bladed to the proper section and compacted under traffic the following spring. While there is sometimes considerable loss of winter gravel due to muddy sub-grade conditions in the spring this is more than overcome by the lower cost of the winter work and by the advantage of having the surfacing deposited and in good condition before the road would otherwise be ready to carry any traffic. Even without these advantages, it is good business to haul this heavy tonnage in the winter in order to avoid the damage to earth and gravel roads over which the material must be hauled, and which are badly cut up by such hauling in warm weather.

Winter Paving.

At first thought it does not appear that much advantage is to be gained by winter work in connection with paving operations, but in this field there is an opportunity to not only cut the cost of paving work but also to save many of the delays encountered in the summer time due to shortage of material and congested shipping conditions. This can be taken care of if the highway departments contract their paving in the fall of the preceding year and provide for partial payment to contractors for materials produced and stock-piled. It is not reasonable to expect a contractor to purchase and stock-pile material during winter months unless provision is made to pay him monthly for doing that work, but if this is done there is an incentive for him to purchase and store his materials during the slack period, thereby furnishing winter employment to a part of his regular force, and what is more important, shipments may be made while cars are available and consequently the usual delays for lack of cars and aggregates can be avoided, and the materials may be bought at a lower price. The writer took this matter up with a number of operators of rock crushing plants, all of whom agree that if road contracts are let sufficiently in advance to allow for the continuous operation of crushers during winter months that the reduction in cost of producing rock would amount to from 12 to 20% below the cost when quarries are only operated during warm weather. The items making this possible are briefly: that an increased tonnage for the year decreases the interest and overhead charge per ton of output, as well as decreasing the depreciation and other fixed charges which are not dependent entirely upon plant operation. The labor turnover is less, for the same men may be employed throughout the year and the operator is also given the advantage of skill acquired by men continually employed in the same kind of work. There are, of course, disadvantages to winter rock producing such as the difficulty of proper lubrication, the breakage of castings, and added cost of protecting pipe lines, but in estimating the above stated decreased cost these things were taken into account. There are many other items of construction which can well be taken care of in the winter, such as the distribution and laying of track and pipe lines, the erection of central proportioning and loading plants, preparation of equipment, etc., but practically all of the winter construction work which can be done to advantage is predicated on the early letting of contracts and payment of monthly estimates for preparatory work, which if arranged for will in itself make for development along this line.

The foregoing paper by Mr. Muller was presented at the recent annual meeting of the American Road Builders' Association.

POWER PLANT PROGRESS DURING 1922

By Prof. A. W. Cole, Purdue University, Lafayette, Ind.

The effort to obtain supremacy in any line of business by concealing improvements in processes and equipment is now generally considered futile. Present day practice is frankly to discuss the problems and difficulties of each particular concern in order to reach a solution which will benefit all alike.

The past year has been one of continuous progress in the field of Power Plant Engineering. A brief discussion of this progress should be of great interest to all engineers interested either in the production or use of power from a Central Power Plant Organization. Let us first glance over the field of Prime Movers.

Turbines

No great or marked changes have been made in turbine construction. Much, however, has been done on details in an effort to increase efficiency and reliability. Refinements in materials and workmanship have continued to occupy much attention, and it is now recognized that

high efficiency depends largely upon improvements along these lines.

In Europe the trend in turbine design is toward higher speeds, higher superheats, and higher total temperatures.

Emergency Governors

It is now standard practice to equip old and new turbine machines with emergency governors set for 1 or 2 per cent over normal speed. The advantages of short range governors are apparent in case of system trouble. With the new governors the necessity of disconnecting the unit from the load and dropping the speed below normal or stopping before resetting the governor, is avoided. In the General Electric units of large size the emergency governor is arranged to control the main governor as well as the throttle.

Turbine Wheels

The General Electric Company has developed a system of tests by which turbine wheels can be vibrated by means of a solenoid or other external means. Wheels which are thus shown to be subject to certain kinds of vibrations at or near their normal speeds are considered dangerous, and their removal or rejection is therefore recommended.

Turbine Generating Unit Performance

In the U. S. an effort has been made to evolve a method whereby the performance of turbine generating units can be compared, irrespective of the service. A similar effort is being made abroad.

Condensing Equipment

The use of varnish to protect the entering ends of condenser tubes, or the insertion of liners or ferrules to take the wear, is being tried in many cases. The success of these devices is still to be proved.

Circulating Water

The concentration of impurities in the cooling water used in condensors, due to recirculation through spray ponds and cooling towers is often the cause of serious scale formation. To avoid this difficulty the circulating water is being treated chemically or Monel or bronze linings are being used in condensing equipment, to prevent corrosion.

Cleaning of Condensers

Considerable progress has been made of late in solving the problem of cleaning condensers, without removing the equipment from service.

Hydraulic jets are employed to free the condensers of matted material, but are not effective for removing slime and adhesive materials. The jets appear to be of greater value in horizontal than in vertical condensers.

Compartment condensers offer another solution for the problem. Their use allows a part of the apparatus to be cleaned at a time while the remainder is doing the work of the whole.

Tube cleaners are easy to operate, but are not always effective in removing slime. Compartment condensers permit complete cleaning. Which method will prove best in any given case depends upon the particular installation and the nature of the deposits.

Expansion Joints and Condenser Supports

Three kinds of joints between condenser and turbine are now employed, the rubber expansion joint, the sliding joint with mercury seal, and the packed sliding joint sealed with water.

Rubber joints are apt to give trouble if not carefully supported or if subjected to varying degrees of pressure. Where the latter condition prevails the joint should be supported by steel rings, one on the outside and one on the inside, to prevent breathing and cracking.

One large power company reports that mercury seals are difficult to maintain, owing to the fact that it is hard to get cast iron mercury-tight, because of the minor flaws that are apt to appear in the cast iron. Dust or dirt getting into the mercury seals also causes trouble.

Large condensers are so heavy that it is not possible to support their whole weight on the turbine outlet. A device has been perfected by which the condenser is weighed; the proportion of weight on the turbine is measured by using hydraulic jacks. Four jacks are used, each operated by a single hand pump and equipped with a gage. During the erection of the condenser and before bolting it to the turbine, jacks are placed under the spring supports; in this way the condenser is weighed empty. To this is added the calculated weight of the cooling water and thus the total weight is obtained. After bolting the condenser to the turbine, the jacks are adjusted to carry the proper spring weight; the spring supports are then blocked in this position. With this apparatus the checking up of the spring load may be accomplished at any time.

Boilers, Superheaters and Economizers

During the past year no boiler plants of unusual size or type or of widely different operating conditions have been installed. There is a continued tendency toward the use of higher boiler pressures

up to 350 lbs. gage and a superheat to a total steam temperature of 700 deg. F.

Superheaters

Research indicates that as boilers are installed with a larger ratio of combustion space to heating surface there will be less variation in superheat over a wide range of boiler capacity. Variation of superheat is dependent not only upon the ratio of superheater surface to boiler heating surface, but also upon its location with respect to the boiler heating surface, the action of the flame on the fuel bed, the kind of fuel burned, and the temperature of combustion.

On account of the increasing tendency to operate boilers at higher sustained ratings and to require as constant a superheat as possible, more attention must be paid to the baffling of boilers. Marked preference is being shown for the use of individual baffle walls, which permit gas passages to be arranged to suit the designer and the velocities of the flue gases.

Soot Blowers

The commercial value of mechanical soot blowers over the hand operated type has always been questioned. The problem, however, appears to be one of local conditions. If the size and height of the combustion chamber be increased, it is not improbable that soot blowing may be reduced to a minimum.

Economizer

Opinions differ greatly as to whether scrapers or mechanical blowers are more advantageous for cleaning soot from cast iron economizer tubes. The concensus of opinion seems to be strongly in favor of the use of mechanical soot blowers, rather than scrapers. The reason for this preference is that scrapers require a large number of holes in the top of the economizer, and these holes permit a large quantity of air to enter the casing, especially when induced draft is used for higher ratings. It is also felt that the scrapers by their ironing action pack onto the outer surfaces of the tubes a compacted deposit which forms a good heat insulator.

Refractories for Stoker Furnaces

A number of manufacturers are now offering a composite fire brick which is much more refractory than the earlier type made from fire clay alone. These bricks are usually produced by blending high grade fire clay, beauxite, and other ores having a high aluminum content. The capacity of fire clay bricks to support loads when exposed to high temperatures is now a serious limitation upon furnace temperatures. This limitation can be overcome by using higher grades of refractory material costing several times as much, or by reducing the temperature of the furnace walls relative to the temperature inside the furnace. This latter end may be accomplished by blowing air currents along the walls on the inside of the furnace, or by cooling the outside of the walls with water or air circulation, thus increasing the radiation through the brick and reducing the temperature.

Preventing Clinker Adhesion to the Brick Work

The most popular means of preventing clinkers from adhering to the brick work of furnaces is the use of perforated brick block along the clinker line. Through these perforated bricks air is blown from the stoker air ducts. The results have so far been satisfactory. Carborundum brick only gives good service with certain classes of coals.

Stokers

The tendency in stoker design is to refine the apparatus so that higher thermal efficiency will be secured. This practice has led to larger furnace volumes and larger stokers.

Chain grate stokers are now being adapted to the burning of coal under forced draft. Power agitators are being used in the fuel hoppers so that the fuel will feed uniformly.

A notable advance is to be observed in the more general adoption of the rotary ash-discharge type of stoker. This device permits the burning of a greater per cent of the carbon out of the coal and consequently less carbon appears in the refuse. It also results in a substantial labor saving. The refuse is discharged cold, and usually dry, which is likewise an advantage.

Station Auxiliaries

Reliability of operation in station auxiliaries is the great demand at the present time. Progress in the segregation of the control devices of auxiliaries has gone so far that in most cases the auxiliaries are now under the control of one man.

Boiler Feed Pumps

For purposes of reliability practically all boiler feed pumps are now turbine driven. A few electrically driven pumps have been installed. One company is using two sets of pumps with cast iron economizers. Low pressure pumps deliver to the economizer, and high pressure pumps deliver from economizer to boiler.

Installations are about evenly divided between single and double suction pumps.

Forced Draft Fans

The tendency is toward motor-driven forced draft fans. Practice is divided between individual fans for each boiler and a common duct with several large fans discharging into it. Even with individual fans it is the usual practice to have a connecting duct for emergency use. In some cases fans are being used as large as 250,000 cu. ft. per minute against 6 ins. of water.

Coal and Ash Handling

No change of any consequence has taken place during the past year. The use of hot tunnels for the thawing of coal is being abandoned because of the cost. Pneumatic chisels are being tried instead of the hot tunnels. Automatic coal samplers have not gained in favor. The disposal of ash by sluicing appears to be gaining slowly in popularity.

Station Piping

Pipe line welds as made a few years ago are proving dangerous. But welded pipe joints reinforced by sleeves are proving very satisfactory. In high pressure service steel body valves are being used with Monel metal parts in contact with the steam. Experiments are now being carried to secure better designed power-operated valves for emergency conditions, but no conclusions of value have yet been reached.

Instruments

Two new automatic CO2 recorders have been tried with success, checking within 1 per cent of the Orsat.

Trouble has been experienced with some of the multiple U-tube draft gages on account of the liquid leaking out and making frequent checking necessary.

Some attempts have been made to measure condenser leakage electrically. They have not been so successful as it was hoped they would be, because of the variation of soluble and suspended matter in the condenser cooling water.

Ash-Pit Loss Records

A recording gas-filled bulb thermometer has been devised for recording ash pit loss when traveling grates are used. The bulb extends nearly across the furnace and is located at the rear of the grates. It is exposed to the radiant heat of the material discharged from the rear of the grate. By proper calibration it is claimed that the temperature record can be made an index of the fuel rejected to the ash pit.

Oil and Gas Engines

During the year no important changes have been made in oil and gas engine design. A single cylinder engine with as high a rating as 2,000 h. p. has been reported. This seems to indicate that large powers may be safely developed in a single cylinder.

High-Pressure Steam

The average American practice favors 300 lbs. steam pressure and a total temperature of 650 deg. F. Several plants are now operating at 350 lbs. gage pressure and a temperature of 700 deg. F. Foreign practice tends to slightly higher pressures and temperatures. Germany offers an example of 900 lbs. gage pressure. It is a general practice for all auxiliaries to use the same pressure as the main power units.

Station Buildings, Foundations and Sites

The chief consideration in the location of a power plant is the cost of obtaining and carrying water and the cost of carrying away the output. The cooling water is the most bulky and is usually the determining factor.

Apparatus which needs frequent attention or which must be protected from the weather must be housed. There is a growing tendency to install as much apparatus as possible out of doors, especially high tension electrical apparatus, transformers, lightning arresters and switches; also water softeners, coal and ash bins, breechings, induced draft apparatus, and coal and ash handling equipment.

A laboratory, locker room and first aid room should be provided; adequate shower baths and toilet rooms should be considered a necessity. In many cases sleeping quarters, in addition to the regular equipment, are proving an advantage.

Location near a railroad is always an advantage. The heating and ventilation of the station should be carefully worked out in each case.

As a rule it is advisable to use reinforced or massed concrete for foundations rather than steel. This construction is much less expensive than steel, and much better.

Buildings constructed of concrete throughout are usually too costly to be practical. For this reason, steel brick and tile are entensively used. Tile floors while easily kept clean are expensive to

install and maintain. Concrete is generally accepted as the best floor for central stations.

The grounds around the station should be kept neat and attractive at all times. They should usually be surrounded by a good metal fence.

Pulverized Fuel

In cement mills, copper refining and allied processes, pulverized coal is now being used at the rate of about 13,000,000 tons per year. It is also becoming a real factor in the steam power plant field. Much work is now being done to develop efficiency in this direction.

By-Products

The extraction of by-products from coal may become profitable when the market value of these by-products is sufficient to offset the cost of processing. The chief product is either a solid fuel with low volatile content, resulting from low temperature gasification process. The by-products in both cases are tar, oil, ammonia, and the former process gaseous fuels.

Burning Low-Grade Fuels

During the past year no progress of importance has been made in burning Lignite and similar fuels.

Oil, Gas and Liquid Fuels

In the use of oil, gas, and liquid fuels no substantial advances have been made.

Lubrication

Lubrication is not at present satisfactory, owing both to the oil itself and the method of applying it. A committee is now at work trying to find means to remedy existing difficulties. Standard methods of testing as well as specifications for bearings and oils are being formulated.

The details of power plant progress during 1922, as thus summarized indicate a very substantial progress in Mechanical Engineering, which is encouraging to those of us who are interested in engineering education.

The foregoing paper by Prof. Cole was presented at the recent annual meeting of the Indiana Engineering Society.

IOWA PRACTICE IN PROGRESSIVE CONSTRUCTION OF HIGHWAYS

By C. Coykendall, Assistant Chief Engineer, Iowa State Highway Commission, Ames, Ia.

No single problem is provocative of more difference of opinion than that of the proper policy for the development of a highway transportation system. Nor is it surprising that such should be the case, for there is no one proper solution to the problem. Obviously, the proper solution of Rhode Island's highway problem will not apply equally well to the highway problems arising in Texas, nor can a solution that is proving effective in Pennsylvania be unqualifiedly recommended for Wyoming. The problems arising in connection with the building of a system of highways are manifold, and fortunate indeed is the state which has highway laws flexible enough to fit all conditions within the state, and officials in charge of highway work possessed of sufficient vision, courage and authority to apply the proper solution to the various problems confronting them. If such a state there be, let it be known, in order that the law makers and highway officials of other states may journey thence and become enlightened.

Iowa's Road Problems

Iowa's road building problems are not exactly duplicated elsewhere. The state has 56,000 square miles in area and more than 104,000 miles of rural highway, with practically every one of these miles, to a greater or less degree, an essential part of the state's highway transportation system. Every section of the state is productive, and consequently is inhabited. Excluding the population resident in cities and towns, it is found that the density of rural population is remarkably uniform throughout the state, with a correspondingly uniform need for a usable system of rural highways throughout the state.

Nature of Traffic

Let us consider for a moment the sources and kinds of traffic that the roads in Iowa are called upon to carry. The surplus products of all sections of the state must be hauled over rural highways to the shipping and market points, and from these same shipping and market points, coal, machinery, lumber and other materials and supplies must be hauled back to the farm. Heavy tractors for operating threshing machines, corn shellers and silo fillers must be able to move from farm to farm, and for this purpose substantial bridges are necessary. A constantly increasing percentage of the children of the state are being educated in modern, consolidated schools, and the school busses in which these children ride to and from school nine of every twelve months of the year, must have safe and usable roads and bridges over which to travel. In those sections of the state within a radius of 50 miles of great meat packing centers such as Souix City, Omaha and Nebraska City, it is found highly

economical to market livestock by truck instead of by train, as it is found that the increased transportation cost by truck haulage is much more than offset by the small shrinkage in weight of the livestock hauled by train. In the vicinity of all considerable centers of population, slow and costly railway and express service is being supplemented by motor transport. Two of the nation's best marked and most widely-known transcontinental highways, and many other important but less widely-known interstate highways, cross the state. Yearly the interstate traffic on these highways is increasing. Traffic counts taken during the past season at a point east of Ames, where for a short distance the Lincoln Highway and the Jefferson Highway use the same road, show that of a total average daily traffic amounting to 1,036 vehicles, 148 vehicles, or 14.3 per cent. of the total traffic, were motor cars with foreign licenses. And last, but by no means least, the five hundred thousand motor cars owned in Iowa are decidedly active organisms, penetrating every nook and corner of the state, on business or pleasure bent, and requiring roads—usable roads.

If Roads Had Kept Pace With Traffic

From the foregoing, it will be seen that the various classes of roads in Iowa are called upon to carry almost every known variety of modern highway traffic, and the suddenness with which most of this traffic has developed is the element that makes the problem of providing adequate highways so stupendous. If the development of highways in Iowa during the past decade was to have kept pace with the development of traffic using those highways, there should have been constructed during that time at least 2,500 miles of paved road, at least 25,000 miles of graveled or similarly surfaced roads, another 25,000 miles graded and drained, and the remaining mileage maintained in usable condition and safely bridged. Such a program of improvement would have cost approximately a half billion dollars, whereas the actual total highway expenditures during this period amounted to approximately $195,000,000, or 39 per cent. of what would have been necessary had highway improvements kept pace with the development of highway traffic.

Investment in Motor Vehicles

On the other hand, during the same period of time the people of Iowa have invested more than three-quarter billion dollars in automobiles, thus showing a much greater liberality in the financing of privately owned rolling stock than in the financing of publicly owned road beds.

Conditions Prior to 1904

In most respects the citizens of Iowa are conservative. Having no great centers of population, her policies as a state are formulated largely by the people of the rural communities—people whose personal prosperity has resulted from conservatism in their personal affairs and who naturally are wont to apply the same policies to public affairs. Logically enough, therefore, Iowa's highway policies have always been conservative. Until 1904, Iowa as a state took no part whatever in road building activities. All such work was under the supervision of county and township officials. Bridges of 16 ft. span or more were known as county bridges and were built and maintained by the county. In addition to this, county boards of supervisors had authority to levy a small tax, known as the county road tax, the proceeds from which could be spent on road work by the county supervisors at their own discretion as to location and type of improvement. As the condition of roads and bridges was a matter almost wholly of local concern, logically enough the administration of highway matters had remained vested in local officials.

Drainage Structures First

About twenty years ago, when it first began to occur to some of the more forward-looking that the existing method of handling matters pertaining to roads and bridges might not be all that could be desired, it was natural that bridges and culverts received first consideration. Travelers on the road at that time could usually choose favorable weather conditions for making their trips, but the bridges and culverts had to be crossed. Further, about this time the heavy steam tractor was coming into more general use and was playing more or less havoc with flimsy bridges. Naturally the owners of these tractors wanted better and safer bridges built, and these same owners, through their state threshermen's association, later proved to be one of the most effective agencies in securing progressive road legislation.

The State Highway Commission, created by legislative enactment in 1904, was vested with only advisory powers. Such counties as desired could avail themselves of the Commission's engineering services and advice, although there was nothing obligatory that such advice must be fol-

lowed. Accomplishments during the period that this system was effective—1904 to 1912 inclusive—were entirely along the line of progressive construction. A large number of counties commenced building bridges and culverts of permanent construction and cutting down hills and filling hollows adjacent thereto. Toward the close of this period the use of large blade graders drawn by gasoline tractors became quite general, resulting in the building of a considerable mileage of dirt roads to a natural grade, and to sections closely approaching present day standards. Very little surfacing work of any kind was undertaken except for short stretches of gravel surfacing here and there in progressive communities where an abundance of local gravel was available.

Legislation of 1913

In the spring of 1913, radical highway legislation was enacted by the state legislature, which resulted in a complete change in the method of handling highway work. This legislation reorganized the State Highway Commission, clothing it with drastic supervisory powers, and providing adequate funds for its support. Under this statute the state continued its policy of non-participation in the cost of road building, but required all highway construction work, both road and bridge, to be done in accordance with plans and specifications either prepared by or approved by the State Highway Commission. Other outstanding features of this legislation were the requiring of each county to employ a county engineer to supervise road and bridge construction work, and the classification of highways into a county system and a township system, the former being placed entirely under the supervision of county officials, and the latter remaining under the jurisdiction of township officials, with the restriction that any construction work upon the township road system must be done in accordance with plans prepared by the county engineer and approved by the State Highway Commission.

Some Real Strides Made

Under this scheme of operation, real strides were made in the way of progressive road construction, particularly upon the county road system. By the end of 1916, approximately 1,600 miles had been built to established grade in accordance with approved plans; approximately 25,000 bridges and culverts had been constructed of so-called permanent construction; practically the entire mileage of the county road system—some 15,000 miles in all—had been constructed to natural grade and standard section and was being rather systematically maintained; in fact, Iowa had acquired a reputation for having a remarkable system of dirt roads—remarkably good under favorable weather conditions and remarkably muddy during rainy weather. Still but little surfacing work had been undertaken, road building efforts and revenues as yet being devoted to the building of earth roads and substantial bridges and culverts, with here and there a few rather desultory attempts at gravel surfacing.

Federal Aid

The coming of Federal participation in highway building necessitated further changes in Iowa's highway laws. Such changes were brought about during the legislative sessions of 1917 and 1919. A further classification of highways was made, a limited trunk line system of approximately 6,600 miles being designated as the Primary Road System, upon which all Federal Aid allotted to the state, as well as all revenues derived from the licensing of motor vehicles, must be expended. The remaining mileage of highways was classified as secondary roads, approximately 11,000 miles of which constitute the county road system, and the remaining 87,000 miles still being under the supervision of the township officials.

The Primary Road Fund

Under this revised legislation the policy of progressive construction persists. The Primary Road Fund—Federal Aid and revenues derived from the licensing of motor vehicles—is divided among the various counties of the state in proportion to their area, providing a fund of approximately $90,000 annually to the average county for improving and maintaining approximately 67 miles of primary road. Obviously this fund is not sufficient to make possible any considerable progress in building roads having a high type of surfacing, and except in those few counties that have taken advantage of a provision of the law which allows anticipation of future allotments of Primary Road funds through the issuance of county bonds, the improvements undertaken on the primary road system consist largely of completing the construction of roads to established grade, providing the necessary drainage and drainage structures, and when this has been completed, surfacing with gravel or sand-clay construction. In addition to the inadequacy of funds heretofore mentioned as restrictive to a pav-

ing program, the law imposes further restrictions in requiring the question as to whether or not the primary roads of a county shall be hard surfaced to be submitted to a vote of the people of the county. The further provision that when hard surfacing is authorized, 25 per cent. of the cost thereof is assessed to abutting and adjacent property, acts as an additional deterrent in getting a hard surfacing program under way.

Progressive Construction

Accomplishments toward the improvement of the primary road system since its establishment are therefore largely along the line of progressive construction. On Dec. 1, 1922, of the 3,653.5 miles of the primary road system that had been constructed to established grade and the necessary drainage and drainage structures provided, 334.4 miles had been paved and 1,558 miles had been gravel surfaced, leaving 1,761.1 miles without surfacing of any kind. A large percentage of the mileage that has been gravel surfaced will need to be paved some time within the next decade if traffic is to be adequately served. In the meantime, however, traffic on these 1,558 miles of gravel surfaced highways is getting reasonably efficient highway service, whereas the same funds invested in pavement would have given traffic a high grade of highway service on only approximately 150 miles.

It will thus be seen that up to the present time road building in Iowa has been hedged about with restrictions that make any policy other than that of progressive construction, entirely immpracticable. Neither is it believed that Iowa is the loser on that account, nor that the opposite policy of highway improvement, that is, the concentration of available highway revenues upon a limited mileage of high type roads, would have given traffic upon the highways in Iowa a service comparable to the service that has been given. The dirt roads that have been constructed to established grade and the necessary drainage and drainage structures provided, give vastly better service than do the ungraded, undrained, and poorly bridged highways. Also, the highway that has been graded several years in advance of the time that it is to be hard surfaced is in much better condition for hard surfacing than is a newly graded highway, particularly so in locations where the topography is rolling. To hold to 6 per cent. maximum grades on some primary roads in Iowa requires upward of 30,000 cu. yds. of earthwork per mile. Experience teaches that the resulting fills under these conditions require two or three years to become stabilized and that a rigid type of surfacing should not be attempted on these fills until they have become thoroughly stabilized.

In conclusion, it may be said that the policy of progressive construction of highways in Iowa is a logical result of its traffic needs and its highway laws, which after all are in a measure reflective of traffic needs. Under this policy, substantial progress has been made. If highway traffic is to be given anything like the service it deserves, however, there must be no undue hesitation about taking the succeeding steps so necessary to the success of such a policy. Based on present costs, at least one hundred million dollars must be spent during the next five years on constructing and maintaining the primary road system alone, if traffic is to be only reasonably well served. An equally large expenditure should be made during that period on secondary highways. It is not a case of the state not being able to afford such expenditures; rather it is a case of the state not being able to afford to do without the highway service that will result from such expenditures.

The foregoing paper was presented by Mr. Coykendall before the recent annual meeting of the American Road Builders' Association.

WHY MT. PLEASANT, MICH., PAID $39,750 FOR A $15,000 WATER IMPROVEMENT

By C. H. Peterson, City Manager, Mount Pleasant, Mich.

The $15,000 water improvement bond issued in 1892 cost the city of Mt. Pleasant $39,750.

This is a condition that one might find, upon close examination, has existed in a good many other cities in the United States. Long term bonds have been quite generally used in the past, but modern methods of city finance have diverted to serial bonds and a great number of cities have gone so far as to provide in their charter that all bonds issued shall be serial bonds.

The water department of the City of Mt. Pleasant is municipally owned. In 1892 it was not on a paying basis, so the city issued a $15,000 long term improvement bond to run for a period of 15 years at a rate of 5 per cent. During these 15

years, there was no money set aside in a sinking fund to pay for this bond when it became due in 1907. It seemed that each council that was in power during that time did not know of this bond or else they wanted to keep the tax rate down during the term of office, so, when the 15 years were up and the bond was due, there was no money available to retire this bond unless the council should put an additional amount in the taxes that year and raise the whole $15,000 in one year. This would seem a disaster to the taxpayers to have this additional amount to pay in one year when they were only raising $17,400 in taxes for that particular year to carry on the expenses of the City. This would make the rate for that year $18.20 per $1,000 instead of what it originally was, $9.80 per $1,000. We all know very well what the sentiment of the taxpayers would be if any council should raise the tax rate about double over the previous year. So the only resort that the governing body could revert to was to refund, which they did.

This $15,000 bond was refunded for a 4½% rate and I compliment the council for getting the interest rate lower, but it was refunded on a long term basis for 20 more years instead of making it a serial bond, this bond maturing in 1927. Again the same mistake was made.

Not a cent was put into a sinking fund to relieve this bond until June, 1922, when $2,500 was appropriated by the commission, and it was recommended that the same amount should be appropriated each year for the next five years, making a total of $15,000 to retire this bond on July 15, 1927.

The following will sum up the cost of the $15,000 water improvement. Interest on the first bond for a period of 15 years at 5 per cent is $11,250. Interest on the second bond for a period of 20 years at 4½ per cent is $13,500, making the total interest paid $24,750, plus the bond itself, or $39,750. If this bond had been made a serial bond at 5 per cent for a period of 15 years, we would have paid $6,000, plus the bond. or $21,000, making a saving of the difference between $39,750 and $21,000, or $18,750.

In other words, if this bond had been a serial bond, the taxpayers would have saved enough to pay the taxes for the year of 1907.

This particular bond is only one of several such bonds that this City has had to shoulder. We are now paying the City debts that should have been paid 15 years ago. No wonder that taxes are high.

Again I say, "Let us pay as we go and relieve ourselves of that burdensome interest. Pay for what we get when we get it and do not pass it on to George."

NEW HIGHWAY BRIDGES TO CROSS MISSOURI RIVER

By B. H. Piepmeier, Chief Engineer, Missouri Highway Commission, Jefferson City, Mo.

For many years Missouri has lacked adequate facilities for highway crossings of the Missouri River. This has been a serious impediment to commercial and social intercourse between the two sections of the state. The three existing highway bridges at Kansas City, Jefferson City and St. Charles are too widely separated to give the needed service and are, moreover, toll bridges.

However, this unsatisfactory condition is about to be remedied. The prospect of securing a state road system has stimulated new activity in the promotion of several bridge projects that have remained in a dormant stage for a number of years.

The State Highway Commission has very properly recognized the need for these lines of communication between the two sections of the state and has recently approved four projects for highway crossings and allotted Federal Aid money to them.

These projected bridges are to be constructed at Boonville, Glasgow, Waverly and Lexington. All are now under contract and the substructure work of the Boonville bridge is well under way. All are high level bridges with sufficient clearance above standard high water to render unnecessary any type of movable spans.

The Boonville bridge will have a steel superstructure 2,665 ft. long and a substructure of concrete piers resting upon bed rock, the lowest elevation of which is 84 ft. below standard low water. A reinforced concrete trestle approach 447 ft. long connects the main structure with an earth fill confined between long wings of a U abutment for 117 ft. At the north end of the bridge is another earth fill approach 442 ft. long. A clear roadway of 18 ft. 8 ins. is provided. The estimated cost of this structure is $526,640. Consulting Engineers are Harrington, Howard and Ash.

The Glasgow bridge consists of four river spans, approximately 1,224 ft. total

length. The approach at the Glasgow end is nearly 300 ft. long and is composed of three deck spans. An earth fill 225 ft. long connects the approach with the city. For the west approach, four deck spans totaling 384 ft. are provided. An earth fill approximately 440 ft. long connects the approach with the mainland. The river piers rest upon bed rock about 38 ft. below standard low water at the deepest place. A clear roadway of 21 ft. is provided. The contract price for this structure is $566 312.50. Consulting Engineer F. W. Adgate.

The bridge at Waverly consists of five river spans, having a combined length of nearly 1,610 ft. Piers are sunk to bed rock about 53 ft. below standard low water. The approach at the Waverly end is made up of one deck truss span and two deck girder spans having a total length of 345 ft. A short earth fill connects the approach with the streets of Waverly. At the north end an earth fill terminates the bridge. A roadway of 20 ft. between wheel guards is provided. The contract price is $585,146.32. Consulting Engineers, Harrington, Howard and Ash.

The Lexington bridge has a steel superstructure 3,071 ft. in length. Bed rock is approximately 100 ft. below low water. On the Ray County side, an earth fill connects the main structure with the mainland. On the Lexington side the main structure is connected by a steel trestle with the city streets. A roadway 20 ft. in the clear is provided. Contract price is $1,169,114.10. The additional length of superstructure and the greater depth to bed rock explains this greater cost. J. A. L. Waddell is the Consulting Engineer.

The completion of these four large bridges will go far towards giving Missouri a basis for a comprehensive road system connecting all parts of the state.

TESTING FLOW OF WATER IN GRAVEL STRATA AT SOUTH BEND, IND.

To the Editor:

In connection with the engineering investigations incident to the development of the water supply for a water works pumping station having an ultimate capacity of 25,000,000 gals. daily, which I now have under design for the City of South Bend, Indiana, I have concluded a test determining the direction and rate of flow in the gravel strata that may be of interest to your readers.

In order that you may more readily grasp the necessity for making the test, and the significance of the results, a brief review of the growth of the South Bend Water Utility is necessary.

The original system was built in 1873 using as its only source of supply the St. Joseph river and it was not until 1880 that any other supply was available.

In 1880, ten 6-in. wells were sunk to a gravel strata approximately 100 ft. below the surface, and subsequently additional wells were drilled in 1895. The entire supply was from this source with no connection for pumping from the river. This was done with no special investigation as to the source of supply, the assumption being that the underground storage was either seepage from the river or the result of percolation from precipitation on a rather restricted area as indicated by the topography in the immediate vicinity of South Bend.

This assumption was satisfactory and computations indicated a sufficient supply for the comparatively light requirements of a small water utility.

The growth of the city has been such that future development demanded a more specific knowledge of the source and extent of the underground water supply, and for this purpose the test was conducted.

A study was made of the direction and density of growth, and the incident extensions to the distribution system to determine the most economical location for the construction of a station. This was followed by test borings to ascertain the grading of the gravel in the water bearing strata.

Following the location of a desirable water bearing gravel, a 12-in. well was drilled to a depth of 155 ft. and this well surrounded by 2½-in. wells at a radius of 6 ft. from the central well and to the same depth; the central well was charged with salt and Basic Fuchsin, and each of the surrounding wells equipped with an electro couple connected through a sensitive ammeter to the 110-volt lighting circuit. Hourly readings were taken through the electro couple on all of the wells and, to insure the sampling of the vein one gallon of water was pumped from each well hourly and examined, by comparison with the original samples, for traces of color.

The time required for the flow of 6 ft. was 82 hours, as evidenced by the reduction of resistance in the electric circuit and the positive color traces in the sam-

ples pumped. The direction of flow is slightly north of true northwest.

While the result of this test is not conclusive, it is confirmatory to my belief that the underground water supply enjoyed by the City of South Bend is not in any sense local in character, but is derived from a water shed extending up from Lake Michigan and Lake Erie to a summit approximately at the Indiana-Ohio State Line.

This belief is further confirmed by the logs of a number of wells with which I have come in contact in my engineering work in this territory in the past 15 years.

Very truly yours,

JOHN W. TOYNE,

Consulting Engineer and Superintendent of Water Works, South Bend, Ind., Jan. 16, 1923.

ST. LOUIS PAVING PROGRAM

The City of St. Louis has adopted a program for municipal paving for 1923, amounting to approximately six million dollars. Like most American cities, the St. Louis paving fell far behind the demand during the war period and the years immediately succeeding. The street paving itself dropped down to an average of approximately 12 miles a year for 4 years. While this to some extent has been made up in the work of the last two years, the condition is still far from satisfactory. The program for 1922 amounted to two and a half million dollars, but on account of the strike situation approximately one-third remains uncompleted. The program for this year of six million dollars will be more than one hundred per cent increase over last year, and about five hundred per cent of the average work for several years preceding.

All of this work is paid for in special tax bills, which requires that the contractor must finance the work until completion, and then take payment in tax bills bearing six per cent interest. These bills are first lien on the property. This tax bill provision has apparently prevented small outside contractors from coming in on St. Louis work during the period of expanding business, and may make it difficult satisfactorily to place the business proposed for this year.

In addition to this program of special tax work, which will probably be continued for several years to come, St. Louis voted the issuance of bonds on Feb. 9th, which included among numerous items, about five million for cash payment paving work, and about nineteen million for sewers and related construction. Mr. W. W. Horner is Chief Engineer of Sewers and Paving.

COST OF PAVEMENT REPAIRS IN NEWARK, NEW JERSEY

By J. W. Howard, C. E., Consulting Engineer, 23½ Mt. Prospect Ave., Newark, N. J.

Newark, New Jersey, is a manufacturing city of 500,000 population. It has heavy traffic of motor vehicles not only within it but connecting it with New York, Philadelphia, etc.

The streets are well paved and kept in good repair. The cost of repaving or maintaining each kind of pavement is analyzed and tabulated so as eventually to determine what kinds of pavements are most economical.

The annual report for 1921 of the Director of Public Improvements shows the cost of repairs per square yard of pavement bases and of surface layers separately and added together.

The total paved streets on December 31, 1921, was 282 miles. The principal kinds of pavements are shown in the table below.

The city has an excellent municipal asphalt pavement plant equipped with storage bins, conveyors, steam rollers and street tools. This plant cost $76,355, not including the land. This plant repairs all old asphalt pavements and lays some new ones on new locations. The cost of repairs made by the City plant in 1921 to the pavements which have passed the five-year guaranteed periods of the original contractors is shown in the following table:

COST OF 1921 PAVEMENT REPAIRS BY NEWARK, N. J., CITY ASPHALT (ETC.) PLANT

Kind of Pavement.	Surface Layer Sq. Yds.	Surface Layer Per Sq. Yd.	Concrete Base Sq. Yds.	Concrete Base Per Sq. Yd.	Total Both*
Sheet Asphalt	51.499	$1.8126	3,979	$2.3313	$4.1439
Granite Block	27,815	1.5262	1,131	2.6651	4.1913
Brick	6,679	3.4968	3,236	4.1820	7.6788
Asphalt Block	126	4.2169	59	2.9908	7.2077
Wood Block	4,168	4.4164	3,487	1.5341(v)	5.9505

*Total Both—means where surface and base were repaired at same locations.
(v) Repairs to base of wood block pavement consisted of replacing injured 1 in. mortar cushion with another on the existing good 6 or 8 in. concrete base below.

Construction News and Equipment

HEAVY TRUCK HAULAGE ON HIGHWAY CONSTRUCTION

By Charles H. Fry, President Chas. H. Fry Construction Co., Erie, Pa.

The title of this paper implies a certain preference for heavy duty trucks for haulage purposes in connection with highway construction, particularly when presented by an author whose experience has led him into favoritism for this type of hauling equipment.

Although several standard methods have gained preference among various highway constructors in various sections of the country, we are allowed to assume that the road constructors and the equipment manufacturers and distributors are all determined upon one definite objective, i. e., in his estimation, have governed his management in the selection of the heavy duty truck for haulage. The author confines production progress with the least necessitated amount of waste, i. e., waste capital (investment) waste labor, waste material, waste efficiency, waste what not.

In the last analysis, we aim for the minimum cost per unit of laid concrete, excavated or filled earth or rock.

The proposition which concerns the contractor in his everyday experience with the trade, is what method attains the common objective and proves itself superior over all other methods? This is a question not easily answered.

Therefore, in the presentation of this paper, the author desires to draw attention to those determining factors, which, himself to a discussion of haulage equipment serving in the construction of macadam, gravel, "stone" and concrete roads.

Variety of Roads

The natural sand-gravel roads such as as abound on and near those flat plateaus surrounding and adjacent to the Great Lakes, as well as similar natural roads found in other sections of our country, also the rock formation forming the sub-base for so many of the roads in the mountainous districts of the United States, without a doubt, serve best for permitting the utilization of the heavy duty truck. This type of sub-base permits the early escape of water from rainfall and consequently discourages layup of heavy duty trucks at times when saturated clay and muddy roads would necessitate costly loss of time from continuous operation. Such a factor has contributed toward making the author a heavy duty truck enthusiast when possibly a highway contractor in some other section of the country would favor a different method.

One point to consider in this connection is: in how large an area of our country can the heavy truck be utilized to distinctive advantage? The factors to be considered in this paper point the way to a comprehensive survey. Recent charts compiled and edited by the Associated General Contractors of America, showing the seasons of the year suitable for road construction purposes in the various States of the Union, will serve as a guide in reaching a conclusion.

Hauls

Closely related to the foregoing and hardly less important is the subject of hauls. Obviously the only ones to be considered are short and long hauls. Other things being equal, the advantage is constantly growing in favor of heavy duty trucks because of the increasing tendency toward longer hauls on contracts being let by State Highway Departments.

The long haul utilizing heavy trucks reduces the amount of field supervision, such as is necessitated when fleets of small trucks are on the road. One striking advantage in operating fewer units is the obvious absence of contributing causes toward units getting in the way of one another. Simple though it may seem, this is a very important consideration in the hills and in the mountainous country removed from the Lake Region and the flat country of the Middle West. The long haul manifests the advisability of heavy units, particularly when taking into consideration the availability of experienced and dependable labor.

Co-ordination

We cannot intelligently discuss haulage characteristics and requirements without taking fully under advisement the correlated equipment and special appliances which are utilized in the other operations.

Like all industries, which, in their pioneer days, were hampered and delayed from time to time because of inadequate facilities and lack of improved equipment, so was the road construction industry handicapped in its early days. Of late years, however, the industry has been the beneficiary of many improved types of equipment, so that instead of becoming impoverished because of neglect or indifference, we find ourselves today reinforced along every avenue of exertion by improved and, in numerous instances, highly developed and patented road building appliances. These have been devised to ameliorate the obstacles long contended with.

The equipment manufacturers have proven themselves practical students of a stupendous industry as is testified to by the numerous dependable types of labor saving road construction equipment now on the market.

We have both ends of the haul to consider, not ignoring the requirements that demand attention between the two extreme points of operation. Between the measuring and striking off points and the unloading point at the paver skip, the heavy duty truck stands as a supreme testimony of efficiency. As the old adage goes—"An early start is half the race."

Gliding into position under an improved and latest design measuring and striking off hopper, a heavy duty truck stops for the fractional part of a minute, swallows its load of four standard six bag batches of aggregate and is off on the last leg of the journey in no more time than is required to do the same thing with the one batch only on a light truck.

And when the big truck arrives at its destination, backing into the paver, the fewer the trucks, the less the disturbance along the way and at the paver itself.

Maintenance

Without entering into an analysis of pure cost data or summarizing along this particular line, there are outstanding merits in favor of heavy trucks along lines of pure operation and maintenance.

The restricted labor supply of the past warrants the conclusion, comparatively speaking, that a few dependable and seasoned truck drivers of known qualifications form an operating force far superior to a larger force of doubtful personnel.

The trained driver on the big truck, educated to maintain his unit and to take pride in its performance is an asset to your organization and a factor to be considered in getting the unit of pavement laid at the minimum of cost. The maxim is efficient drivers and maintenance men, and they are ordinarily few, particularly when labor is at a premium.

In this connection, it is known that heavy trucks are slower than light trucks, nevertheless, there is apparently an advantage in wear and tear. It appears that the heavy truck stands the vicissitudes of operation to more marked advantage—the rugged frames, the heavy wheels, the big tires, the staunch bodies, as well as the enlarged members of motor, driving and transmission machinery, the ability to take punishment, seem to stand the gaff are readily amenable to satisfactory overhaul.

The great, strong, dependable units take their place admirably in helping to weave the cloth of progress.

Flexibility

When the contractor finds himself in the market for the purchase of transportation equipment, without a doubt he finds himself dealing with the most complex problem of road building. To arrive at any decision he must consider so many details that in the end he generally feels that he has reached only the experimental stage. There is a constant and inviting incentive to attain the best results. In touching some of the major problems consider first the investment. The expenditures for any type of hauling equipment is the largest item of the contractor's plant. This fact alone should cause the contractor to choose the most flexible equipment.

In the selection of motor haul equipment the road constructor must be governed by the various requirements which will manifest themselves from time to time during the progress of his management.

When he considers that he will be forced from time to time into competitive bidding upon all kinds of road contracts presenting multifarious conditions, the contractor, of necessity, must plan upon a suitable degree of flexibility. Heavy duty trucks provide for this flexibility that cannot always be provided for under other methods.

Other Determining Factors

Heavy trucks provide general adaptability. Even in seemingly unimportant ways, they are adaptable. In storage alone they require less space during layup and during idle time. Innumerable times they serve to manifest an indisputable advantage in towing other types of equipment. They augment the facility with which the general equipment is

moved on and off the job. In the matter of grades, experience has proven that the heavy unit will pull up and take any grade that the light unit can negotiate.

In the matter of sub-base, the greatest argument against heavy trucks seems to have been accusation that the sub-base was subject to an excessive amount of cutting up; but experience substantiates the contention that when sub-base conditions are at all favorable, the big trucks with their wide tires iron out the sub-base and pack it down like a roller. From the standpoint of public interest this provides a more substantial job.

Conclusion

In summarizing the elements of this paper, the author, with the brief amount of time available and naturally forced to the employment of general statements, has endeavored to point out the main factors which through analysis have placed him in the position of a heavy truck enthusiast.

He has been favored with the privilege and opportunity to operate and study different haulage methods, more or less of the time, of course, in a locality and at seasons of the year well adapted for the utilization of heavy units. And he has no argument with other contractors who may have a cherished method altogether different which may be entirely laudable and entirely adequate for the conditions encountered.

As far as truck haulage is concerned some contractors conclude that it is fitting to hire their hauling equipment instead of owning and operating it outright, and in this connection one has to consider that the number of dependable trucks available whose owners are willing to operate at a figure satisfactory to the contractor, enforces a determination of the rate of progress of the work under way.

And after all methods have been analyzed, the pros and cons discussed, the weak and the strong points compared, the legitimate contractor is brought face to face with a recognition of the merits of vision and the benefits of far sighted management. He must realize that no method, however good, will attain the objective unless there lies within his organization the common desire to function to the best advantage, unless throughout the organization from president to waterboy there is imbedded the keen desire to see the organization put the job across in the best possible manner to the best advantage of all concerned.

The foregoing paper by Mr. Fry was presented at the recent annual convention of the American Road Builders' Association.

IDEAL SECTION OF LINCOLN HIGHWAY BUILT AT MODERATE COST

With the completion of the paving of the "Ideal Section," a model stretch of road built in Northern Indiana by the Lincoln Highway Association with funds contributed by the United States Rubber Company, nation-wide attention has been focused on the road. A vast amount of discussion upon highway design and specifications has been stimulated. This was one of the aims of the Lincoln Highway Association in building the Section.

The Association has long felt that more public thought should be given to the nature of the improvements resulting from the investment of the hundreds of millions of dollars now going into highway construction in this country annually. According to officials of thet Association, the American public, which in the loing run is paying the bills, has not taken sufficient interest in the adequacy and performtance of the highways being constructed. Too frequently public ignorance of the problems confronting highway engineers and commissioners has resulted in mistaken public pressure for road improvement which was not properly designed to carry the traffic it would receive. The result has been inefficiency and waste.

Public Understanding of Road Problems Required

Highway engineers and commissioners in many sections of the union have not had the support of the public in undertaking farseeing improvement plans which, while seemingly expensive, would ultimately save the public large sums in maintenance and reconstruction costs and in facilitating travel.

A. F. Bement, Vice-President of the Lincoln Highway Association, in a recent address said: "The Association is gratified that such great public interest has centered on its short section of model road, designed by the foremost highway engineers and other authorities in the union. It is anxious that that project shall be well and correctly understood.

"The press in some sections of the country has, we believe, presented an exaggerated picture in regard to the cost of the improvement. The fact is, economy, not in first cost, but in ultimate cost,

was always before the technical committee appointed by the Association to design the Ideal Section for the traffic of today and tomorrow. The hard-headed men who determined upon the plans for the road, which it was hoped would serve as a model for many years, had no intention of being impractical or extravagant. Many of them were public officials, having in charge the expenditures of millions of the public's funds for road-building. They did not advise the Association to attempt any construction which could not be economically justified."

The Cost of the "Ideal Section."

The Association states that in some way the impression has gained currency that the Ideal Section cost $100,000 a mile. This is not the case. The cost of the reinforced pavement, which by the public is generally considered as the "road," was but $64,897.20 per mile. This for 40 ft. of concrete, 10 ins. thick and reinforced with 80 lbs. of steel to the 100 sq. ft. It will be noted that for the ordinary 20 ft. width, this road would have cost but $32,450 a mile, even though it was much more heavily reinforced and 2 to 3 in. thicker than the paving now being generally laid in many sections of the country.

Two bridges were included in the Ideal Section link and these two structures cost a total of $23,174.26. These expenditures are by no means extravagant. They represent true economy for the volume and type of travel the Ideal Section of the Lincoln Highway was designed to carry.

Additional funds, of course, were spent by the Association in the development of the design, and in the carrying out of the many added features recommended by the technical committee. The cost of the landscape work, which involved much preliminary planning it would not be necessary to duplicate if 100 miles instead of one were beautified, was $4,800 per mile, while the cost of illuminating the Section for night travel was but $4.051 per mile. In handling a project of this character money was necessarily expended on expert engineering consultation and in the infinite amount of red tape required to perfect the arrangements with the Federal Government, the State, and the County and the property owners. The benefits of these expenditures are available to any community in the country in the shape of detailed specifications and plans which may be had upon application without expense.

Adequate Width and Strength True Economy

Considering the economy of the Ideal Section's design for heavy volumes of traffic, it should be remembered that maintenance cost will be practically nil for many years, while the original improvement will carry the increasing traffic of the next 10 to 20 years without reconstruction.

The cost of a mile of road cannot be standardized. The sum justifiably to be spent in proper improvement varies with every changing location and condition. The State of New York has just finished the construction of four miles of road along the west bank of the Hudson River, between West Point and Cornwall, known as the "Storm King Highway" after six years of the most difficult work and at an expense of $700,000, or a cost of $175,000 per mile. The need for this road more than justified the expense.

The State of New Jersey has expended over $80,000 per mile on the construction of certain sections of the Lincoln Highway. Unless the conditions are fully known, no one can say whether this sum represents the truest form of economy or the utmost extravagance. The Lincoln Highway in New Jersey carries, in addition to the heavy volume of local traffic, the ponderous trucks operating out of Baltimore, Philadelphia, New York and Boston, and the through traffic from the South and West, reaching New York from Philadelphia. The old pavement, which was replaced by the New Jersey State Highway Department, consisted of a reconstructed macadam base, with a 2 in. bituminous surface. It provided for two lanes of traffic on a paved width of 18 ft. This section was built in 1915 and the repairs due to the heavy traffic cost the State $14,250 a mile, during 1920. New Jersey did a wise thing to tear out this old road and build a modern highway, providing for four traffic lanes, with a paved width of 32 ft. and a graded width of 40 ft. and 9 ins. of Portland cement concrete.

The Ideal Section was designed to carry a traffic of 20,000 vehicles per 24 hours and it can do so with safety, convenience and economy. The Lincoln Highway Association is anxious that the general public appreciate the careful thought and consideration given to the question of cost in connection with the construction of its model section, which without doubt will some day be continuous from Chicago to New York—as a matter of economy.

REPAIRING A SMALL BRICK SEWER BY CEMENT GUN METHOD

By R. A. Mac Gregor, Assistant Engineer, Department of Public Works, Borough of Manhattan, Municipal Bldg., New York, N. Y.

It was found that the 3ft. 6 in. x 2 ft. 4 in. brick sewer in 41st Street between Madison Avenue and 5th Avenue, Borough of Manhattan, New York City, was in serious need of repair. Considerable areas of the first ring of the crown had fallen in and at one or more places both rings had fallen in. The joints were badly washed out, most of them for 2 ins. or more.

The use of the Cement Gun was considered for this job and decided upon after careful survey had been made and an estimate prepared of the cost of repairing by opening up the street for about 140 ft. and making other repairs from the inside. This estimate amounted to $2,845.

A cement gun outfit with two operators were hired through the Cement Gun Company, the city supplying all materials, gasoline and labor, other than the operators.

The first operation was to remove any loose bricks in the crown and to attach expanded metal to any areas of more than about 2 ft. square where the first ring had fallen in. This was done with 1-2 in. lag bolts or wood screws and the slight irregularities of the brickwork kept the expanded metal away from the bricks sufficiently to allow the gunite to reach behind the metal.

The first sections of the work were cleaned with a sand blast without water, but it was found that water alone cleaned the surface quite well with the advantage of leaving no sediment to be taken out of the sewer.

This sewer happened to be a clean one, with very small flow so that the sides and crown were not greasy. In most cases the sand blast would probably be needed to insure a good bond between brick and gunite.

The small size of the sewer, only 3 ft. 6 ins. high, made work difficult. As the nozzle could not be held far enough away the gunite did not spread as much as usual and a rougher surface was left.

From the spring line down, therefore, the surface was trowelled with a plasterer's trowel and a surface at least as smooth as good brickwork was easily obtained.

A coat of about 1 1-2 in. thickness was first applied over the expanded metal and left over night, and next day about 1 in. more was added. This gave about 2 1-2 in. of gunite in place of a 4 in. ring of brick, but in addition all joints in the second ring were thoroughly filled with gunite.

At one place a boulder about 12 in. in diameter had penetrated the second ring and earth was showing around it. Gunite was carefully applied here and left overnight and next day more was applied making at least 3 ins. of good concrete.

The entire interior surface down to the water line was coated with about 3-4 in. of gunite, this also filling all the joints as no hand pointing could do.

With an air pressure of 60 lbs. as commonly used, about 30 per cent of the sand was lost as rebound and had to be taken out before night as sufficient cement was carried in it to make it troublesome to remove in the morning. It was found that 30 lbs. of air pressure was sufficient to carry the sand the distance required and that with this reduced pressure only about 15 per cent of sand was lost.

The sand was well graded, practically all passing a 10 mesh screen and was carefully measured in a box for a 1 to 3 mix.

The cement was added making 9 cu. ft. of sand and 3 bags of cement, the whole turned over with shovels once and then put through a ¼-in. screen to prevent any larger balls of cement reaching the gun. This mixing and screening was done close to the gun to save labor in charging the same. After a rain the sand was rather wet, but a damp sand is to be preferred as the cement then adheres to it while passing through the hose.

A total length of 300 ft. of sewer was relined, 400 sq. ft. of expanded metal were used where the first ring had fallen in, and the time actually worked by the gun outfit was 11 days. The city gang was longer on the job as the gun outfit had to be taken away in the meantime for another job and then returned.

The entire cost to the city including hire of gun outfit, all materials and labor, hauling materials and removing waste and debris was $1,830, over $1,000 less than the estimate for work done in the ordinary way. Had the outfit been owned by by the city a greater saving would have been shown as there were unavoidable delays in getting the gun delivered twice, in breaking in the gang to new work, etc.

This work was done in September, 1921, under the supervision of the writer.

A careful inspection was made of the sewer in December, 1922, by the writer and another engineer. After more than a year not a single defective spot was found, no cracks were visible and under the hammer the lining rang hard and sound. Practically a new sewer has been secured.

In larger sewers the work would be done more comfortably and cheaply and this sewer is about the smallest size in which such work is possible.

HOW TO DYNAMITE ICE GORGES

Damage, amounting in the aggregate to millions of dollars, is often caused at this time of the year by floods and freshets, due to ice gorges and ice jams in rivers and streams. At times these gorges so choke running streams that serious damage is done to bridge piers, bridges, dams, and other obstructions. Frequently also they cause water to back up, inundating adjacent country so that damage, inconvenience and sometimes loss of life is caused.

It is possible in many instances to obviate all danger by using dynamite to break up the ice gorges. When explosives are used for this purpose, the blasts should be directed at the key or pivotal points of the gorge. Two general methods of loading are practical:

(1) Holes are cut through the ice at spacings of from 8 to 10 ft. and the charges, the quantity of which must be governed by the thickness of the ice, thrust through the holes and allowed to be carried under the ice a little way from the holes. Such blasts heave the ice and thus break it apart.

(2) Large mudcaps (unconfined charges) are loaded on the top of the ice at frequent intervals, and fired.

As this work must, as a rule, be done on short notice, little time is afforded to obtain the correct explosive, so the recommendation is made for any low freezing dynamite available. Electric firing should be used for safety as well as for the benefits derived from all charges firing at exactly the same time.

Moving floes of ice must usually be broken by the second method. The explosive primed with a blasting cap and a short section of fuse can be dropped on the floe from the shore or from the down stream side of a bridge.

It is difficult to give any definite amounts of explosives to be used for blasting ice, but where the broken ice is 3 or 4 ft. thick, the charge of explosives should be not less than 10 lbs. Where the ice gorge runs up to 20 and 30 ft. in depth, it may require 1,000 or 1,500 lbs. of dynamite fired under it to obtain any results.

GOOD YEAR FOR ENGINEERING EMPLOYMENT

All indications point to a banner year for engineering employment according to the Employment Department of the American Association of Engineers. Resumption of activities after the usual year-end pause has started with noticeable effects throughout the country. There is a great demand for engineers, particularly designing engineers, and salaries for these technical men have taken a broad increase during the past two months. An average increase on starting salaries amounting to over 10 per cent, has become effective in many organizations.

The structural steel line has been the most active during the past few months. The number of construction projects and volume has been large and more projects of this nature, particularly industrial buildings and highway construction, will be started this year. Indications are that all records will be broken. We will see a billion dollar improvement year for railroads.

In a survey made of the country, practically all sections show very little unemployment among professional engineers, a scarcity of men for engineering work, and office men are at a premium. The city of Los Angeles is required to hold up some important municipal projects because of its inability to engage competent checkers on the necessary plans. Conditions on the Pacific coast for engineers are excellent with the exception of the northwest where the winter season has tied up construction work. The southwest section of the country is fair and the mountain states are about balancing the supply and demand. The central states show the greatest activity in engineering work with practically no unemployment and an average of two positions for every competent designing engineer. The southern and south Atlantic states show activities fair with some construction work starting and highway work taking on activity. The eastern section shows some unemployment among engineers at the present time.

DEVELOPMENTS IN CONCRETE PAVEMENT DESIGN

By Willis D. P. Warren, of Holbrook, Warren & Van Praag, Civil Engineers, Millikin Bldg., Decatur, Ill.

The general use of concrete as a paving material did not begin until a little over ten years ago, for, as a matter of fact, the total yardage of concrete pavements laid in 1912 was reported as only 5,381,218. When it is realized that the total concrete pavement yardage laid to date is in excess of 300,000,000, it may be seen that the growth of this type has been most phenomenal.

In considering this great increase in concrete pavement yardage, it may be of interest to review developments in design, and to endeavor to point out certain principles which should be emphasized on future work.

Early History of Design

The use of concrete as a paving material was the result of early experience with concrete built for walks and driveways. Many of the first pavements were of a thickness and mix ordinarily used on such classes of construction, and little regard was paid to the necessity for richer mixes, and practically no thought given to the importance of structural design.

There was a period of several years after early construction began before it was fully realized that the structural design of a concrete pavement involved complex problems of unusual occurance.

Literature of Ten Years Ago

As indicated in 1913, the lack of commonly accepted principles in the design of concrete pavements, brief extracts from the literature of ten years ago will be of interest. This situation was pointed out in an editorial published in Municipal Enginering for July, 1913, here quoted in part as follows:

"Probably the most difficult of all the concrete construction problems which engineers have had to face and solve is the proper design and construction of concrete pavements. Although only a comparatively recent innovation, attended with the usual costly failures and experiments of any new type of construction, surprising progress has been made. Engineers can recall the difficulties that marked the early stages of the simplest types of concrete structures which taught the lesson that concrete is merely a structural material, subject to certain laws governing strength, elasticity, etc., and they have profited by this initial lesson."

"It is obvious at a glance that the considerations involved in the construction of concrete pavements are more complex and multitudinous than in building or foundation work, but it is not generally understood as yet just where the marked differences in the two types of construction lie."

It is quite interesting to note a portion of the Report of Com. XIII, National Conference on Concrete Roads, 1914, and the fact that the usual practice of the day was emphasized, rather than any carefully tested principles of design.

Following is a brief summary of the Report of Com. XIII:

"Because of the fact that the members of this Committee have had their attention directed chiefly to the conditions obtaining in the northern states, it is not without some misgivings that they suggest the following as conforming to the best practice.

1. Where the width of roadway is not greater than 16 feet, with a porous subsoil, subgrade in good condition and well packed and with loads not exceeding 6 tons, including the vehicles, a thickness of 5 ins. at the edge of the slab and 7 in. at the center is sufficient without reinforcement, using slabs not greater than 16 ft. sq . . . ."

Reference was also made to concrete pavement design in the editorial columns of Engineering & Contracting under date July 9, 1913, in part as follows:

"Concrete road construction is in the development stage. Few of its requirements have been settled definitely. The use of expansion joints is in particular undetermined by practice. General opinion holds such joints to be necessary but deplores the necessity. . . ."

"It is apparent from the evidence of experience so far with concrete roads that joints have not caused undue worry. The article which we publish in this issue aims to demonstrate that they are not to be avoided at all hazards, but should be accepted as a safe and economical structural resort. We believe that the argument of this article is well worth careful consideration."

Bates Experimental Road

In 1920, the Bates Experimental Road was started. The tests in connection with this road have extended over a period of time sufficient to give us much valuable data, and in fact probably the most valuable yet collected. While other experiments have been undertaken on a comprehensive basis since the Bates Road was

started, the work has hardly progressed to the point reached by the Bates tests.

The experiments being conducted by the U. S. Bureau of Public Roads at the Arlington Experiment Station in Virginia are aimed primarily at the obtaining of information which is of importance in connection with the structural design of roads, and offer data of immense value to future construction.

The reports on the Bates Road tests are full of data of the most vital importance in the economical design of concrete pavements. They confirm in no uncertain manner the wisdom of this scientific investigation, and suggest the value of future studies and tests.

Application of New Data

The writer desires to emphasize that it is "the application of information and data" and not the data itself which is of value, for we frequently have in our offices much information and data of interest and importance, but until we apply it to the practical problems at hand, it is in reality of little value. Not only can we apply much available data of today to the problems of concrete pavement design for highways, but we can also apply such data to the problems of concrete pavement design for city streets.

The more general use of *joints*, of *circomferential reinforcement*, of *denser concrete*, and also a wider *range* in *selection* of *materials*, are factors to be carefuly considered in the design of future pavements.

It is the belief of the writer that full use has not as yet been made of the data at hand as the result of the Bates, Arlington and other experiments.

Dense Concrete

Dense concrete can be produced by tamping, which assumes a dry mix, and therefore not proper for pavement construction or it can be produced by removing excess water, and by mechanical processes.

In removing such excess water the concrete is necesarily compacted and thereby its density increased, as well as its strength. Removal of excess water from concrete pavement materials is recognized as good practice. However, such removeal, when accompanied by some movement of the mass of concrete, both laterally and vertically will produce a mixture of very substantially increased density and strength.

The possibilities in this direction appear to justify considerable further study, as any feasible plan which will permit of so working the surface of the pavement as to force the coarser material from the surface, will afford a much wider range in the selection of materials. In this way a less durable quality of stone may be used for the pavement proper, provided a suitable quantity is provided for the wearing surface. The removal of all excess water is very essential.

Longitudinal Joints

In considering longitudinal joints, it will be of interest to contemplate the extent to which joints may be properly used on our wider pavements. Consider the recent design of two different concrete pavements. One improvement was planned and constructed 56 ft. in width, 12 ins. in thickness, with fabric reinforcement and with longitudinal constructing joint in the center. The other was constructed 18 ft. in width and may be further described as Sections 48 and 49 on the Bates Road. These Bates Road sections were constructed 5 ins. thick, both being provided with longitudinal joints, and one with circumferential reinforcing in 9 ft. by 25 ft. sections, the other with similar reinforeing in 18 ft. by 25 ft. sections. When it is understood that these 5 in. pavements, so designed, withstood the tests and were reported in good condition after completion of the traffic runs on Sept. 2, 1922, when the last of 5,000 night applications of the 8,000 lb. wheel load was imposed on the various sections, it will be more clearly recognized that longitudinal joints in a pavement are not necessarily a structural weakness.

While these comparatively thin pavements withstood the tests on the Bates Road, it is not necessary or proper that we adopt a 5 in. slab. However, it is proper that we give thought to the valuable data assembled as a result of such tests, and apply it in the design of future improvements. It is difficult to conceive of a traffic condition which would require a pavement section 12 ins. in thickness.

The writer, with the late S. T. Morse of Carlinville, Ill., designed one of the earliest pavements built with a longitudinal center joint. This pavement was constructed at Carlinville in 1913, and while it possessed some of the defects common to pavements of that time, it demonstrated beyond doubt the value of the longitudinal joint. With practically no maintenance, it is still in good condition.

Since that time Mr. Morse, until the time of his death in 1921, and also the writer, urged the adoption of a longitudi-

nal joint, particularly on highway work. This early experiment at Carlinville was of value in assisting to establish the principle that longitudinal joints are not to be avoided at all hazards, but should be accepted as a safe and economical structural resort.

The use of longitudinal joints, with the present class of traffic, is not to be avoided as it might have been at one time. There is sound argument in favor of several longitudinal joints for city pavements, one located about 9 ft. out from each curb, and one or more proper intervals between these two, each independently divided section being reinforced with circumferential, or other proper reinforcing.

The following reference to this important feature is quoted from Bulletin No. 18, Bates Experimental Road, prepared by Clifford Older, Chief Engineer:

"On sections where longitudinal joint was provided, the edges of the pavement slabs lifted on an average of about ¾ of an inch, while during the same period the center lifted but an average of about ¼ of an inch. Many sections not provided with longitudinal joints showed approximately the same behavior. All such sections when examined in the spring were found to be cracked longitudinally. A few sections lifted at the edges about ¾ of an inch and at the center about ½ of an inch; these sections showing no discernible longitudinal cracks when examined in the spring . . Mathematical analyses indicate that it is likely to be economically impracticable to design wide slabs of sufficient strength to avoid breaking longitudinally when the edges only are supported."

From the above it may be seen that the use of longitudinal joints and circumferential reinforcing offers exceptional opportunity for more economical and practicable design.

Circumferential Reinforcing.

Many observations and tests have demonstrated the fact that a pavement slab does not receive subgrade support throughout its entire area.

A separation of the subgrade and the slab is to be expected as is evidenced by both the Bates and Arlington tests, and for this reason the use of smaller independently divided slabs with circumferential reinforcing, will prove far more effective and economical in supporting and distributing the weight of traffic.

The following extract from Bulletin No. 18 Bates Experimental Road is of peculiar interest in this connection:

"The results of these observations are of considerable interest. They show distinctly a periodic separation of the pavement slab and the subgrade due to warping of the slab under temperature changes which will be described later. They show, also, to a very marked extent erratic variations due in all probability to uneven settlements of the subgrade . . It is not believed that any economically practical method of compacting a subgrade may be applied with reasonable economy to secure absolutely uniform results."

This data is confirmed by the Arlington investigations, as follows:

"Without going into the details of the test, this curve shows very plainly that the bearing value of a soil having penetrations of the bearing block equal to 0.1 in. varies greatly with the size of the bearing block and that when small bearing areas are used the results are far higher and not at all indicative of the bearing value of the soil for supporting the pavement. This is very important for it points out to us the futility of attempting to make bearing value tests for roads with bearing areas having less than 2 sq. ft."

In the judgment of the writer, the use of one or more longitudinal joints, with necessary transverse joints, with each independently divided slab strengthened with circumferential reinforcing, will be but an intelligent application of the principles above set forth.

Conclusion.

From the above brief discussion, it is readily apparent that great progress has been made in the field of concrete pavement design, and that data of immense value has been collected during the past ten years. Concrete pavement design may now be made on the basis of known data of fundamental importance.

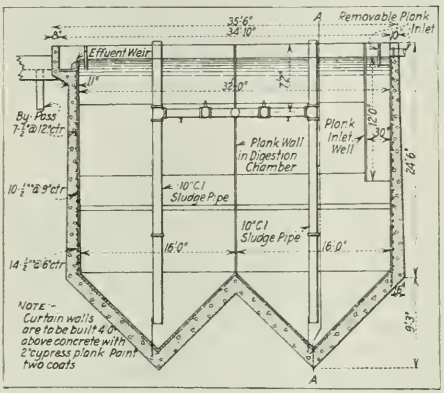
Without neglecting any of the important requirements in the design and construction of concrete pavements, greater emphasis can very profitably be put on the features discussed herein.

A little more vision of the magnitude of our future paving program, and a proper application of all available data in design, will be of immense value to future construction.

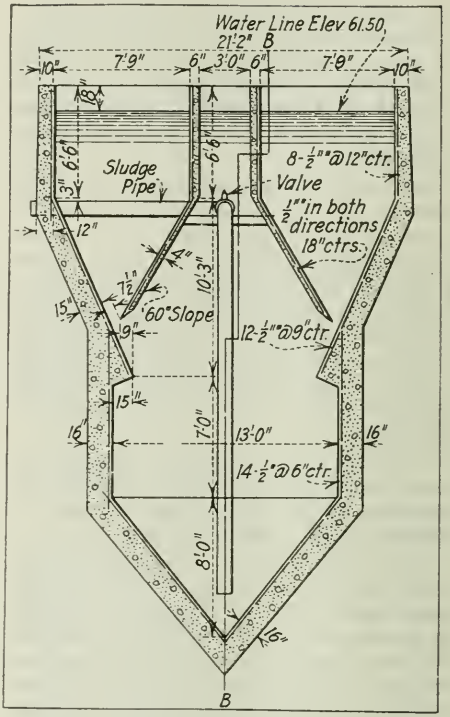
COMPLETE SEWAGE TREATMENT FOR CITY OF 3,000, DELAVAN, WIS.

By W. A. Peirce, Sanitary Engineer, Delavan, Wis.

Delavan, Wisconsin, a progressive city of 3,000 population, has for many years discharged its sewage untreated into the outlet of Delavan Lake at a point a few hundred feet above a mill pond formed

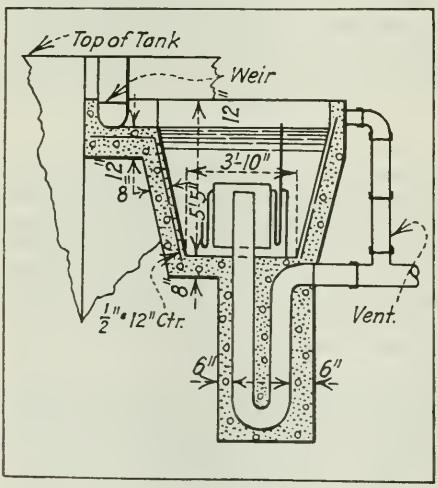

Effluent Weir
By-Pass
Plank Wall in Digestion Chamber
Plank Inlet Well
10" C.I. Sludge Pipe
10" C.I. Sludge Pipe
Removable Plank Inlet
NOTE — Curtain walls are to be built 4'0" above concrete with 2" cypress plank. Paint two coats

LONGITUDINAL SECTION THROUGH PRELIMINARY TANK



TRANSVERSE SECTION THROUGH PRELIMINARY TANK

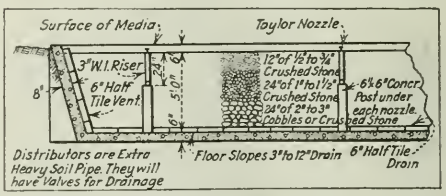
by the damming of Turtle Creek and the above mentioned outlet. This lake is used each summer by many thousands of people for bathing and boating. The



SECTION THROUGH DOSING CHAMBER

usual result of such a practice was observed here; nuisances in form of odor and objectionable sights. Following many complaints by residents to local authorities and to the State Board of Health, the Common Council decided to construct a treatment plant and the writer was ordered to prepare plans.

Gagings showed a discharge of about 75,000 gals. per day from 215 houses and stores. After investigating conditions and testing the sewage the State Sanitary Engineer (at that time Mr. E. J. Tully) recommended in 1919 the installation of a tank of three hours' detention period, followed by percolating filters and specified minor requirements. It was essential that a plant be designed to produce


Surface of Media
Taylor Nozzle
3" W.I. Riser
6" Half Tile Vent
12" of ½" to ¾" Crushed Stone
24" of 1" to 1½" Crushed Stone
24" of 2" to 3" Cobbles or Crushed Stone
6"x6" Concr. Post under each nozzle
Distributors are Extra Heavy Soil Pipe. They will have Valves for Drainage
Floor Slopes 3" to 12"
Drain 6" Half Tile Drain

TYPICAL FILTER SECTION

a very stable effluent as the discharge is into a stream having practically no flow in the summer.

The basis of the design for the various units is as follows:

1. *Preliminary Treatment Tank.* Two compartment, rectangular sedimentation chamber designed for three hours' detention based on daily flow of 210,000 gals. Sludge compartment designed for 1.8 cu. ft. per capita, based on 3,000 population, double hopper bottom.

2. *Dosing Chambers.* These are of 75 cu. ft. capacity, discharging at about 13 minute intervals through 8 in. siphons, one for each filter unit.

3. *Filters.* Five units of trickling filters are provided with 5 ft. (average) media composed of graded crushed stone, two units to be installed at present. The dosage above stated is equal to ½ in. depth over the filter area which is rated at 2,000,000 gals. per acre per day.

4. *Secondary Tank.* This is a small rectangular tank for one hour detention with double hopper bottom and an effective depth of 4½ ft.

5. *Operating Conditions.* Sewage flows under a creek through a 6 in. cast iron siphon 600 ft. long with a drop of 1.6 ft. to the flow line of the tank. This gives a velocity of 1.1 ft. per second and discharge of 150,000 gals. per day. Conditions at the inlet end are such that the head may be built up to 12 ft. thus providing for the increased flow in the future. The siphon is in duplicate with two cleanouts in each line.

The plant is located in an abandoned city gravel pit, the topography giving rise to a rather unusual layout.

General practice is followed in the design, the only special construction being the preliminary tank. This is constructed much the same as the Imhoff. There is, however, a wooden partition transversely through the digestion chamber and gas vent midway between the inlet and outlet ends of the tank. Sewage is introduced into the lower compartment through a wooden shaft and flows upward through the slots and then horizontally to the outlet weirs. This type of tank has alleviated troublesome conditions at a number of plants in Wisconsin, but should it not operate satisfactorily with the local sewage it can be readily converted into an Imhoff. Subsequent to approval of plans by the State Board of Health, the contract was awarded to John Braman & Son of Jefferson, Wis., and is now under construction.

CURING A "SICK" SEWER SYSTEM AT INDEPENDENCE, MISSOURI

By Leon B. Reynolds, of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

Independence, Mo., is a city of about 12,000 population, situated about nine miles east of Kansas City, Mo. The topography of the city is rather rough, with an extreme range of over 150 feet in elevation. The business section occupies the highest ground and the drainage flows in five different directions. These draws fall rapidly and, of course, do not carry much water except during wet weather, and are often entirely dry.

The original sewer system was designed about 1899 and four outlets were provided with sewage disposal plants. The backbone of the system has remained unchanged and lateral extensions have been added as the city has grown. The original sewage disposal plant for each outlet consisted of a shallow septic tank and a contact bed, one of the earliest installations of this type in the country. The septic tanks were circular radial flow tanks 5 to 8 ft. deep; the contact beds were originally filled with alternate layers of brick and coke breeze. By the year 1908 the coke breeze had broken down and the beds had become clogged; at that time the filling material was removed and the beds were filled with layers of sand, stone, gravel, and brick. At the west plant a dosing tank and sprinkling filter were later constructed in order to purify the sewage more thoroughly. The contact beds were later abandoned entirely, the septic tanks ceased to function, due to their filling up with solids, and the sprinkling filter became clogged, due to excess of solid matter being carried over from the septic tank.

Early in 1921 the city engaged the firm of which the writer is a member to examine the sewer system and plants for treatment of sewage and to recommend the necessary improvements. A sanitary survey of the city was made to determine the number of houses connected to the present sewers. The authorities were startled to find that 1,500 houses, or more than half the total number in the city were not connected to sewers; of these 1,500 houses not connected, 700 fronted on streets where sewers were already laid and sewer service was available, and 800 were in localities where no sewers had been laid. The amazing discovery that nearly one-quarter of the population oc-

cupied residences unconnected with the sewers started an agitation to compel the use of sewers where available.

Practically all of the existing lateral sewers were found to be provided with flush-tanks, 101 being the total number. Of this total only thirty-two were found to be operating, forty-one were receiving no water due to the inlet being stopped up or turned off, and twenty-eight were not flushing due to leakage through the siphon or the walls of the tank. In addition to the waste by leakage in the twenty-eight which were not flushing, the water used by the thirty-two operating tanks would have been sufficient to allow each of the 101 tanks to discharge once every sixteen hours. This condition was also rather startling to the city, and may be common to other cities.

Due to the small amount or lack of flow during the summer in the draws used as final outlets the conditions below the sewage plants were very offensive. The north, east and south plants consisting of septic tanks and contact beds were practically not functioning at all and were entirely neglected, while the west plant, consisting of septic tank and sprinkling filter was neglected and its efficiency was low. Damage suits had been threatened and one suit had already been filed by landowners below the outlets and the city was facing considerable litigation. If the Missouri State Board of Health had actively and efficiently regulated the disposal of sewage from cities of that state the existing conditions would have been remedied long before. The most startling discovery of all was that the effluent from the inefficient west plant discharged into a draw about a mile and one-half above Fairmount Lake, located in one of Kansas City's amusement parks, on whose shore is the best natural bathing beach in the city. Physicians stated that they had treated numerous infections among bathers but the cause seemed to be unknown, and the public generally was not aware that the sewage from the west district in which the city hospital was located found its way into this lake. As soon as the real condition became public the owners of the amusement park threatened suit for damages unless the city installed a sterilization plant, and the city promptly installed a temporary plant of this kind to treat the effluent with liquid chlorine. In addition the owners of the amusement park treated the lake with liquid chlorine applied from a plant installed in a row-boat. The effect of these precautions was quickly noticed in the reduced baterial content of the lake water.

A bond issue was put up to the people on the basis of the preliminary report by the engineers recommending new treatment plants consisting of Imhoff tanks, sludge beds, dosing tanks and sprinkling filters for the north, east and south districts and ejector pumping plants for the west, southwest, and southeast districts. The engineers conducted an educational campaign for the bonds and they were voted in June, 1921, by a vote of 7 to 1. Contracts were awarded in September, 1921, to Ray & Son of Baxter Springs, Kan., for the construction work, and to Simplex Ejector Company of Chicago for the ejector equipment. The construction work was completed in August, 1922, and the plants have all been in operation since that time.

The south plant is designed for a flow of 500,000 gal. per day, the north plant for 200,000 gal. per day, and the east plant for 100,000 gal. per day. The settling chambers of the Imhoff tanks are designed for a two-hour retention period on the basis of the entire daily flow occurring during 18 hours with provision for reversal of flow.

The velocity of flow through the settling chambers varies from 0.003 to 0.008 ft. per second; the total depth below sewage level ranges from 19 ft. 8 ins. to 23 ft. 6 ins. The ratio between gas vent surface and sludge room surface is approximately 1:4. Sufficient capacity is provided in the sludge compartment up to 18 ins. below the slot for storage of 150 days' sludge.

Sludge is withdrawn under hydrostatic head of 5 ft. 6 ins. to 6 ft. upon sludge beds having areas of 280 to 360 sq. ft. per thousand population. The sludge beds have a surface sand layer 6 ins. thick and underdrains are 4-in. drain tile.

The dosing tanks are of the ordinary tapered type. The sprinkling filters are designed to operate at the rate of 2,500,000 gal. per acre per day. The best local limestone in sizes from ¾ in. to 2½ in. was used for filling material with a depth varying from 5 ft. to 5 ft. 6 ins. Distributors are of vitrified pipe encased in concrete; Merritt square spray nozzles are used and underdrains are 6-in. split drain tile. The total head through the plants from the sewage level in the Imhoff tanks to the invert of the main drain from the filters is 14.6 ft. at the north

plant, 14.4 ft. at the east plant and 17.8 ft. at the south plant.

Ejector sewage pumping stations were constructed to pump the sewage from the west, southwest, and southeast districts into sewers draining by gravity into the south treatment plant. The west district is relatively small and its sewage including that from the city hospital is now prevented from being discharged into the bathing lake. The southwest and southeast districts are too low to drain by gravity into existing sewers.

At each ejector station there are two Simplex ejectors of 75 gal. capacity, two motor-driven Gardner vertical compressors with short belt and idler drive and Westinghouse automatic pressure regulator control. The discharge lines are 6-in. cast iron pipe; at the west station the static head is 60 ft., at the southwest 24 ft. and at the southeast 56 feet. A moderate speed of 250 R. P. M. was specified for the compressors in order to secure maximum service and reliability with a minimum of maintenance and attendance. Some difficulty was encountered with the unloader equipment due to unreliability of the local power, and bleeder tanks were installed on the discharge lines from the compressors to relieve the pressure and allow the compressor to start against a smaller pressure after any interruption of power of more than 15 seconds.

The total cost of the three sewage treatment plants was $87,950 including land and the cost of the ejector equipment was $11,735. The plants are under the supervision of the Sewer Superintendent, Mr. E. M. Riddle, who was fomerly city engineer and who is giving the plants the attention which they deserve. Some difficulty has been experienced thus far with the Imhoff tanks due to foaming, but the sludge is being kept down by raking and spraying with water, and conditions are improving. A removal of from 70 to 75 per cent of the settleable solids is being secured and a good quality of sludge is being produced. The relative stability of the final effluent is showing a gradual improvement as the bacterial action in the filter beds becomes better established.

The failure to use sewers after they are built and the lack of proper handling of sewage treatment plants, as was found at Independence, is a common fault and really defeats the good results in sanitation that might be obtained by full use and proper operation of sanitary works.

THE BLOOMINGTON, IND., WATER SUPPLY PROBLEM

By Paul Hansen, of Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers, 39 W. Adams St., Chicago, Ill.

The Bloomington water supply problem has attracted widespread attention throughout the state of Indiana because of the presence of the State University in Bloomington, and because during the autumn of 1922 the shortage of water was unusually protracted and severe; but it also has some aspects from the psychological and technical points of view, principally the former, that should prove of interest to water works men.

To give as nearly as practicable in a short paper a clear account of the problem in proper perspective, I will endeavor to trace the history of the Bloomington water works, pointing out along the way the interesting and significant features.

The First Water Company

In 1892, when Bloomington had a population of about 4,500, a franchise was granted to one J. W. Shoemaker to construct and operate a water works plant at Bloomington. This franchise was immediately assigned to the Bloomington Water Works Co. This company developed a supply at the upper end of Spring Branch, several miles to the southwestward of the city. Without any records or satisfactory personal recollections at hand the specific considerations that influenced the selection of the source of supply are not known, but it is reasonably apparent that the promotors of the project were attracted by some springs issuing from the limestone at the head of the valley, and were further influenced by the fact that this was the nearest "visible" supply to the city. Obviously little thought was given to the question of tributary water shed, rainfall and run-off, but there was an appreciation of the fact that the springs did not at times have an adequate flow to meet the requirements of the city, and so a low earthen dam about 13 ft. high at the highest point was thrown across the valley. A pumping station was built just below the dam and pipes were laid to and within the city. The position of the dam, just up stream from a road, was apparently more determined by the road than by needed storage requirements. Unfortunately the dam was founded on Mitchell limestone, a formation which outcrops in a broad band, having a generally north and south direction and lying just to the west of Bloomington. This lime-

stone is extremely cavernous, and its entire outcrop is marked by many sinks and caves. There is probably no other place in the country except in the Mammoth Cave region of Kentucky where sinks form so conspicuous a feature of the landscape. To engineers, therefore, it is not surprising that water found its way around and under the dam in considerable quantities. However, the water consumption remained small and the source met the requirements of the city until 1899, when the first shutdown occurred on account of shortage.

New Company Formed

The Bloomington Water Works Co. had a short life. In 1894, two years after its formation, it went into the hands of a receiver, and remained in the receiver's hands until 1898. In that year the city water works company was incorporated and took over the water works under an arrangement whereby the city purchased a portion of the stock with the understanding that it would eventually purchase all of the stock as rapidly as funds could be made available, and this objective was consummated in 1902. This means of financing was employed because the city could not legally raise enough money through issuance of bonds to buy the water works outright. A similar scheme will be employed to finance the present proposed improvements.

The shortage of 1899 and the following year resulted in an attempt in 1901 to impound more water by raising the dam 12 ft., or to a maximum height of 25 ft. and by plugging the obvious leaks. But the reservoir continued to leak, and such additional water as it was able to hold failed to prevent shortages in 1901 and 1902 with a brief shutdown in 1902. Wet years and a generous spring flow took care of the next few years.

Another Dam Built

In 1904 and 1905 a sewerage system was installed which tended greatly to increase the use of water. To meet the increased demand the city council in the same years and without the formality of obtaining technical advice, built another dam 20 ft. in height a few hundred feet below the original dam with the expectation of intercepting and holding the leakage past the latter. At the same time a new pumping station was built below the lower dam and the old pumping station was abandoned. The lower dam, like the upper dam, was founded on Mitchell limestone, and the water in the lower reservoir, like that in the upper reservoir, found its way through cavities in the rock into the stream below. The net result of the undertaking was some additional storage, nominally 30,000,000 gals., but actually about half this. The city council built a rectangular water-tight concrete basin below the lower dam to catch the leakage past this dam and such as was not needed for city use was pumped back into the reservoir.

A Geologist Offers Advice

At this point it is interesting to note that Dr. E. R. Cummins, professor of geology at the State University, who had made an intimate study of the local geology, ventured out of the sheltered seclusion of his scholastic world and in 1904 gave before the Fortnightly Club a very clear analysis of the Bloomington water supply problem from the geological point of view. This was published in one of the local newspapers. Much to Dr. Cummins' surprise, the article was not accepted by many of the towns people at its face value; in fact, some were inclined to intimate, and did intimate in public print, that Dr. Cummins did not know what he was talking about, or that he was actuated by ulterior motives. It is also alleged that one prominent politician allowed that he, the politician, could look as far into the side of a hill as any professor at the University. However, Dr. Cummins was not easily dismayed, and if the Bloomington water problem is finally solved the credit belongs largely to him for his persistent efforts in enlightening the public.

The address before the Fortnightly club pointed out some characteristics of the local geology that it will be well to discuss before proceeding farther, as they will help to understand what follows.

The Mitchell limestone has already been referred to. It is relatively thin-bedded, has a total thickness of about 200 ft. and slopes, as do all the other rocks in this locality to the west southwestward, at a rate of about 30 ft. to the mile. Drainage throughout the area of the out-crop is very largely subsurface and in places streams of considerable size enter cavities in the rock and disappear. The area also reveals an interesting phenomenon of "stream piracy," so-called, by which drainage that once followed a surface stream has been diverted through underground water worn channels into other drainage areas to the westward. The net result is that actual drainage areas are not coincident with apparent surface

drainage areas. In fact, drainage lines are very difficult to determine. Furthermore the Mitchell limestone is so thoroughly honeycombed with water worn cavities and stratification planes that it is extremely hazardous if not impossible as a foundation for a dam.

Geological Conditions

Underlying the Mitchell limestone is the Oolitic or Bedford limestone with a thickness of about 40 ft., famous and growing more famous all over the country as a building stone. The outcrop of this rock ordinarily does not exceed ½ mile in width though there is a considerable area of outcrop projecting out to the eastward covering the greater portion of the area within the city limits of Bloomington. This rock is thick-bedded and massive with joint planes at wide intervals. The uniform texture of this rock, the ease with which it can be worked, combined with its massiveness constitute its valuable properties as a building stone.

Like all limestone the Bedford is water worn but the cavities are in the form of "mud seams" along joint planes relatively far apart. This rock, therefore, is more suitable as a foundation for a dam inasmuch as the seams are easier to find and easier to plug, but it nevertheless presents some elements of danger on account of leakage.

Below the Bedford limestone is the Harrodsburg limestone with a total thickness of about 90 ft. and an outcrop covering the higher ground over a width of several miles. This rock is quite thin-bedded and more or less water worn, but is not nearly so porous or cavernous as the Mitchell.

Underlying the Harrodsburg limestone is the Knobstone with a total thickness of about 600 ft. and outcropping over a wide area to the eastward. Within three to five miles of Bloomington the Knobstone outcrop is confined to stream valleys, notably Griffy's Creek, Muddy Fork, Jackson Creek and Stevens Creek. The upper 100 ft. of the Knobstone is a very dense, fine-grained sandstone with an argillaceous cementing material. It is soft and easily erroded and hence the valleys in which it is found are deep with steep side slopes. Freshly exposed Knobstone disintegrates readily, but the natural rock faces are more or less protected by case hardening. So long as it protected from the atmosphere it forms an excellent foundation for a dam or any other structure and it is practically bottle-tight against percolation. Furthermore, the configuration of the Knobstone valleys, that is steep-sided with flat level bottoms, is almost ideally adapted to the impoundment of water.

All these considerations relative to geology and drainage led Dr. Cummins to conclude that the valley of Griffy's Creek was the nearest, safest and most economical place to obtain an adequate water supply.

Returning to the history of the water supply—1904 to 1908 were a series of wet years when the water supply was adequate at all times, thus tending to allay popular and official concern. In the latter year occurred the most lasting shortage that had occurred up to that time and this continued into 1909. To relieve this situation water from a spring and runoff from a limited surface area of 1/3 to ½ mile was impounded about ¾ mile south the existing resivoir forming what is known as Weiner's Pond. The dam is an earthen structure with concrete core wall and 25 ft. in maximum height. The storage is estimated at about 50,000,000 gals. Water filled this reservoir for the first time in March, 1909. Apparently this reservoir leaks but little though some leakage has been observed, but not measured.

A Water Shortage

Again a series of wet years helped out the situation until 1913, when a shortage occurred in the late summer and as a result of the discussion that followed the mayor appointed a committee of 17 citizens to investigate. So far as known this committee did not have surveys made and did not have any technical advice other than that available from the geological and other departments of the university. as a result of their deliberations eleven favored a development in the valley of Griffy' Creek and five submitted a minority report in favor of a development in the valley below Leonard's Springs, about 2½ miles in southwesterly direction from the original supply. The presence of fairly large perennial springs, the rather favorable configuration of the valley below the springs for an impounding reservoir and its relatively high elevation with reference to the city as compared with Griffy's Creek made the Leonard's Springs proposition an attractive one to the lay mind. But the- complicated considerations of tributary drainage area, run-off, storage required, storage that could be made available, etc., were more or less lost sight of or at any rate their

true influence and proportions were not fully appreciated. One thing the minority of the committee did know, however, was that in Leonard's Springs valley there was a continuous flow of spring water nearly always, cool and clear, while Griffy's Creek went bone dry nearly every year and if it could be made to yield enough water it would be "only surface water." This consideration seemed conclusive and still seems conclusive to a great many. The fact that the absence of springs was an assurance of a definite drainage area ascertainable from surface topography and also an indication of the imperviousness of the rock, seemed to make no appeal.

University Installs Own Supply

Because of the uncertainty of the city supply the State University was under the necessity of installing a supply of its own in 1911. This was done by impounding a small arm of Griffy's Creek by means of a concrete dam that has proved practically bottle-tight. The tributary drainage area is one-third square mile and the capacity of the reservoir is about 40,000,000 gals., or 133,000,000 gals. per square mile of drainage area. During the past autumn which was an exceptionaly dry one, this supply was easily able to meet the requirements of the university, amounting to not less than 156,000 gals. per day, equivalent to a yeild of about 520,000 gals. per square mile of drainage area per day.

Report of First Expert

Because of differences in local opinion the city early in 1914 engaged the services of Morris Knowles, Inc., of Pittsburgh, to report on the most desirable new water supply for Bloomington. This organization investigated practically all possible sources of water supply, including three developments in Griffy's Creek, Leonard Springs, Jackson Creek, West Branch of the White River, wells in the valley of Bean Blossom Creek and further developments of the existing supply. As a result of a very full investigation, a recommendation was made in favor of a development on Griffy's Creek capable of yielding about 2,200,000 gals. per day as the most economical and the most reliable.

It is interesting to note in connection with the Knowles investigation that the services of Prof. W O. Crosby of Boston, were obtained to investigate geological conditions as affecting the water supply problem. In a very comprehensive and clearly written report he substantiated the findings of Dr. Cummins and definitely recommended against any reservoir in the Mitchell limestone, but indicated a belief that a reservoir in the Bedford or Harrodsburg might be successful, provided adequate precautions are taken.

After further consideration, the city decided in favor of a development at Leonard Springs, comprising an earthen dam with spillway 29 ft. above the valley bottom, thus forming a reservoir with a capacity of about 140,000,000 gals., a pumping station and a pipe line to the existing pumping station. On the basis of an assumed drainage area of 5.9 square miles which is probably several square miles in excess of the actual drainage area the yield in a dry year would be about 750,000 gals. per day. This added to the probable safe yield of existing reservoirs would be a total of about 1,000,000 gals. per day. Another dam could be located below the existing dam so as to take in additional drainage area and provide storage for 500,000,000 gals. approximately. Assuming the entire superficial drainage area available which it is probably not, the daily safe yield would be about 2,000,000 gals.

Report of Second Expert

In 1920 critical conditions again developed, but there was no shut-down. During this year, Messrs. Alvord and Burdick were employed to make an investigation of the best method of developing a new water supply, and their report confirmed the former recommendations of Morris Knowles, Inc., in favor of Griffy's Creek. However. the Alvord and Burdick report recommended a materially higher dam, namely, 52 ft. to the spillway, as against 33 ft. A decision in favor of this higher dam was based on a larger consumption than proposed in the Knowles report and on a long series of run-off records from a small watershed at Lexington, Ky., which records were not available at the time the Knowles report was prepared. A 52 ft. dam would impound about 1,750,000 gals. of water and will provide a safe yield of about 3.6 gals. per day, according to revised computations of Pearse, Greeley & Hansen.

No action was taken as a result of the Alvord and Burdick report, apparently because of a strong popular preference for Leonard's Springs. Why the city should fail to heed the recommendations of water works specialists of high standing is one of the vagaries of municipial psychology. The best explanation I can think of is that such reports are rarely

given the publicity they should be given. Sometimes this is due to the rather involved way in which engineering reports are written, but this can hardly be regarded as the case in the present instance. Certain it is that very little was known about either the Knowles or the Alvord and Burdick reports, even by members of the water works committee, and it is questionable if nine-tenths of the population had ever heard of them. Perhaps this may be food for thought in the matter of preparing and presenting engineering reports on municipal work.

Near Water Famine

In 1922 there occurred the most prolonged and bothersome shortage of record. It lasted from early in October until late in December, during which period industries were all cut off and water for general uses was pumped but three days a week and then only sparingly. Great quantities of water were shipped in on the railroads and water was peddled for as high as $1.00 per barrel. The water pumped was from the bottom of the reservoir and was highly turbid and odoriferous. -The coagulating and sedimenta tion plant were unable to effect clarification because this, too, was generally drawn down to a low level. Some stirring up of mud also no doubt resulted from emptying and filling of mains. Though water was held in reserve for fighting fires it was impossible to attain good pressure short of four or five hours because of the time necessary to refill the mains and because of greedy draft of water by consumers as soon as it would flow from faucets in order to fill bathtubs, washtubs, barrels, buckets and pitchers against the next shut-down.

Report of Third Expert

This near disaster of 1922 stimulated the public and the city officials to do something to avoid the possibility of another shortage in 1923. Pearse, Greeley & Hansen were employed to investigate the relative merits of a project on White River and a project on Griffy's Creek. It was now the point of view of the controlling element in the council that Leonard's Springs was definitely settled as being unsuitable for a new or additional water supply, hence the instructions to the engineers were limited to these two projects.

Pearse, Greeley & Hansen studied the two projects thoroughly and developed the fact that for any population and water consumption that might reasonably be anticipated for the future Griffy's Creek was unquestionably the more economical and suitable.

New Supply Recommended

For Griffy's Creek three modes of development were considered from which it appeared that a development having pumps and filters at the dam with a large equalizing reservoir on a hill near the city gave the lowest total annual charges and lent itself best to economical progressive development.

Each mode of development was considered with reference to (1) a minimum permissible development, (2) an intermediate development, and (3) a complete development. The minimum development presupposes the continued use of the existing supply up to the limit of its safe capacity and the maintenance of the new supply strictly as an auxiliary to meet requirements during periods of shortage. The intermediate project also presupposes the continued use of the existing supply, but provides more liberally for those features which cannot readily be enlarged such as the dam, main pipe lines and equalizing reservoir and would thus permit the use of the new supply as the only source of supply with but the addition of a pump or two and filters. The complete development represents a desirable development that will meet all requirements for about 25 years in the future with the exception of the reservoir which should meet requirements until about 1960.

The proposed method of financing permits of raising but $450,000, whereas it was originally supposed that as much as $600,000 would be raised. The city authorities took the point of view that pipe lines and pumps should be stripped to bare bones and that what remains should be devoted to building the highest dam possible. It is felt that the psychology of having an abundant supply of water will remove present criticism and apprehension and that pipe lines, pumps, etc., can be added more or less readily as needed or as money becomes available.

Details of New Project

In line with this policy Pearse, Greeley & Hansen are preparing detailed plans and specifications for a project comprising a dam, a pipe line from the dam to the city, and a small electrically driven pumping station at the dam. An equalizing reservoir near the city, together with the necessary pipe lines and a filter plont will be omitted for the present, With this arrangement it is anticipated that the city can continue with delivery service as good as it is receiving at the

present time, but with the assurance that there will always be a supply of water. An equalizing reservoir when built will greatly improve pumping economies and ensure good fire protection. A filter plant when built will provide a water always clear and colorless but even without filtration the physical characteristics of the new supply will be reasonably satisfactory and chlorination will take care of the somewhat remote possibility of contamination. The proposed pipe line from dam to city will be 16 ins. in diameter, regarded as the minimum size necessary to deliver enough water to supplement the existing supply during the next 20 years without undue friction losses. The cheapest possible connection will be made to the existing mains consistent with delivering the new supply to the district of large fire hazard and consistent with an economical development of a future improved distribution system which will give good fire and domestic service throughout the entire city and its probable future extensions.

The Dams Considered

In order to obtain a dam of maximum height and hence secure the maximum storage within the present financial limitations bids will be received on five different heights of reinforced concrete dams and two different heights for earthen dams. Bids will be received on both reinforced concrete and earth dams because preliminary estimates indicate that they lie fairly close together in cost. More alternatives with reference to height are being received on reinforced concrete constructions than on earth construction because the former type of construction is better adapted to successive increases in height than is the earthen dam. The considerations which led to limiting alternatives on earthen dam to but two heights namely, the minimum with a spillway of 24 ft. above the valley bottom and the maximum with spillway of 56 ft. above the valley bottom are interesting. Preliminary studies indicated the practicability and economy of building the lowest dam of compacted selected earth placed in layers. Suitable earth is available for the most part on the hillsides, but in limited quantities. A materially larger dam can most economically be built by hydraulic fill methods, utilizing the ample supply of mixed material in the valley bottom which is quite satisfactory for this purpose, but would not be suitable for a compacted embankment placed in layers. The conversion of any dam larger than the smallest into a high dam by means of hydraulic fill would be very awkward. In the first place the down-stream toe of the dam would be in the way of a cut-off trench for a high dam built by hydraulic fill methods and in the second place would interfere seriously with the deposition of core material in the right place. Even with the low dam it is contemplated that a portion of the down-stream toe must be removed to accommodate core material for the higher dam.

Computations also show that assuming that larger storage than that afforded by the lowest dam would be required in the relatively near future, it would be economical to build the highest dam rather than the lowest dam for the reason that building the highest dam as an addition to the lowest dam would cost about $119,000, or roughly somewhat over one-fourth more than the single development would cost. This difference results in part from sacrificing the spillway of the low dam which is necessarily an expensive structure and could not readily be utilized for the high dam, in part from greater unit costs for construction of the low dam and in part from an increase in equipment overhead on that portion of the enlarged dam built by hydraulic fill methods.

In conclusion it may be noted that there is nothing about the Bloomington problem of an extremely complex engineering nature, although the intimate relation of the problem to the local geology, the care and judgment involved in determining upon proper run-off figures and certain features of the designs for earthen dams are rather unusual.

The foregoing paper by Mr. Hansen was presented at the recent annual convention of the Indiana Sanitary and Water Supply Association.

FIELD EXPERIMENTS IN EARTH ROAD OILING IN ILLINOIS

By H. F. Clemmer, Engineer of Materials, Illinois Division of Highways, State House, Springfield, Ill.

Arrangements have been completed and plans are well under way for carrying out some extensive field experiments in earth road oiling during the coming summer near Cambridge, in Henry County, Illinois. The Illinois Division of Highways, in co-operation with Mr. J. H. Reed, county superintendent of highways, plans to construct an experimental oiled earth road of a number of sections employing the

different kinds and grades of oil commonly used in Illinois on some sections and oil in varying quantities on other sections and observing the results under actual traffic conditions. It is also planned to study other important factors entering into the construction of oiled roads among which may be mentioned the effect of soil and subgrade conditions, the effect of extremes of weather conditions and the methods of heating and applying oil.

Extent of Road Oiling

If all the oiled earth roads of Illinois were laid out in the form of a continuous stretch of road, they would make a highway 13,000 miles in length or one that would reach more than halfway around the globe. These roads in 1923 required for their construction 35,000,000 gals. of oil and involved a total cost of about $2,000,000. Approximately 14% of the total mileage of public roads in Illinois is now oiled and no doubt carries a much greater proportion than 14% of the total traffic.

The oiled earth road is not adapted to extremely heavy traffic nor to heavy truck or steel tired traffic, but under moderate automobile traffic this type of road when properly constructed gives excellent service. For this reason the oiled road is best suited for the secondary system of roads where the brunt of the traffic is carried by the paved trunk highway. However, due to the absence of paved roads in many sections of Illinois, the main arteries of traffic have been oiled in some cases with considerable success.

Oiled Earth Roads Popular in Illinois

Surface oiling of earth roads was first practiced in Illinois in about 1910 or 1911 and since that time has made rapid strides until at the present time it constitutes one of the most important methods of road maintenance in the state. This rapid development may be accounted for first by the lack of local supplies of stone and gravel which could be utilized for other types of roads. Second, the rapidity and ease of construction of oiled earth roads. It is usually possible for a county or township to oil and maintain its entire system of roads throughout a season without an excessive outlay of equipment and at a moderate expense. It is possible to drag an oiled earth road practically throughout the year. The oil prevents the surface from freezing tight and otherwise keeps it in condition for dragging when an ordinary earth road cannot be so maintained. Third, a properly constructed oiled earth road is very agreeable to traffic and this feature has contributed in no small degree to its popularity and the demand on the part of the public for its construction.

Problems in Road Oiling

Coincident with the rapid development of the oiled road has arisen a number of problems in connection with its construction and maintenance, among which may be mentioned the following:

1. What is the best kind and grade of oil for earth road treatment?
2. What quantity of oil and number of treatments per season are necessary for the maintenance of an earth road?
3. What are the best and most economical methods of construction, particularly as regards methods of heating and spreading oil, and the preparation of the road surface prior to applying the oil?
4. What effect has the character of the soil and subgrade conditions on the final results?
5. What are the effects of the extremes of weather conditions and what measures can be taken to preserve an oiled earth surface through long dry periods and through the spring "break-up?"

While earth road oiling in Illinois dates back but little more than ten years, it has been practiced in certain other states for a much longer period, but owing to the climatic and soil conditions, and the peculiar varieties of oil available, Illinois has benefited but little from outside experience and the methods of construction, maintenance and oil specifications which have come into use are almost entirely the results of her own experience.

In an effort to find a solution to some of the above mentioned problems and to effect a better and wider understanding of the best method of constructing oiled earth roads, under conditions existing and with materials available in Illinois, this experiment is being undertaken.

ABILENE (TEX) GAS AND ELECTRIC CO. COMPLETE MODEL PLANT

The Abilene Gas & Electric Co., has recently put into operation its new ice and electric plant at Abilene, Texas. The old Abilene electric plant was destroyed by fire in the spring of 1919 and almost immediately plans were begun for the construction of a new plant that would typify the best in modern developments in power house construction. Ground was broken for the new plant on Dec. 23, 1919, and it was formally opened Oct. 25, 1922.

The plant, in which are combined an ice plant and an electric generating station, is located about three-quarters of a mile from the center of Abilene. The electric station serves the City of Abilene and 27 other communities by a system of high tension transmission lines extending in the four directions, and comprising a total of 286 square miles in all. At the present time the company has 8,600 customers, and work has been started on an extension that will serve three more towns and will add 700 customers. The connected load is about 10,000 kilowatts, about equally divided between lighting and power. The peak loads average 2,000 kilowatts and the average daily output from the station is 27,000 kilowatt hours. The territory served is building rapidly and many lighting and power consumers are being connected. Among the power consumers are two plaster mills, six city pumping plants, one street railway system, five cotton gins, and several flour mills, ice plants, grain elevators, etc.

The plant is located on a 14 acre tract. There is a railroad siding from the Abilene & Northern Railroad running onto the property and the Texas & Pacific Railroad has a spur of track alongside of the property, with which the ice plant is connected by a conveyor for loading ice into cars. The plant building is 195 ft. by 115 ft., with a little more than half of the floor space devoted to the ice plant. The building is of reinforced concrete and hollow tile construction and is fireproof throughout.

The electrical generating equipment consists of two units, the first being a Westinghouse 2,500 kv-a turbine-generator with a direct connected exciter. The electrical characteristics of the unit are three phase, 60 cycles, and 2,400 volts. The steam conditions are 200 lbs, 150 deg. superheat and 28 ins. vacuum. The speed of the unit is 3,600 R. P. M. The condenser is Westinghouse with a surface of 4,500 sq. ft. The air and hot-well pumps are Westinghouse turbine driven and a motor-driven circulating water pump is provided.

The second unit is a General Electric 1,250 kv-a. turbine-alternator with the exciter independent and motor-driven. The auxiliaries of the second unit are a 3,000 sq ft. condenser made by the Wheeler Condenser and Engineering Co., a motor-driven hot-well pump, a motor-driven centrifugal pump, and a steam jet air pump of the two stage type.

The circulating water is handled by 65 spray nozzles arranged in clusters of 5 each. A booster pump is used in connection with the sprays. A pond was formed by installing a dam in a creek known as Cedar Creek and intake and discharge flumes leading to an intake crib were constructed.

As a reserve unit a steam-driven G-E. exciter was provided. A 75-kw. motor-driven D. C. generator furnishes current for the local traction company.

Current is generated at 4,150 volts and is distributed through eight feeder circuits. A 33,000 volt switching structure, provided with remote control oil circuit breakers and metering equipment is located on the southeast corner of the property and from it 33,000 volt transmission lines extend North, East, South and West. The switchboard was built by the Westinghouse Electric & Manufacturing Co.

The boiler plant consists of three 414 h. p. Stirling boilers, two of which are arranged in one battery with the third forming a one-half battery, but so arranged that the installation of another boiler will complete the battery. These boilers are equipped with Babcock & Wilcox superheaters for 150 deg. of superheat, and the plant carries a steam pressure of 200 lbs. The boilers are equipped with Duquesne burners of the combination oil and gas type installed under Dutch oven extensions to the furnaces. Gas is supplied at 150 lbs. pressure to a regulation station on the property where the pressure is reduced to 25 lbs. and then to a regulator in the gas meter room where it is further reduced to an 8 ounce pressure. Duplicate meters of 100,000 cu. ft. capacity, arranged for testing, are located in this room.

An oil unloading rack along the plant spur track accommodates two cars at a time. Oil is pumped from cars by a Tennant-Lovegrove motor-driven triplex pump into 160,000 gal. oil storage tank. Near the boiler room is situated an auxiliary oil tank with 1,200 gal. capacity from which a duplicate oil heating and pumping set heats and circulates the oil through the oil burner heaters. The oil burners are of the steam atomized type.

Water, which is obtained from either the City's supply or by gravity from a nearby lake, is pumped into a 7,300 gal. house service, elevated tank and is softened in a Booth water softener and rapid pressure filter. From the clear water reservoir the water is handled by a Yoeman centrifugal make-up pump to a Hoppes opened-feed water heater of 75,000 lbs. ca-

pacity. There are duplicated feed water pumps which are Cameron 4-stage centrifugal pumps driven by Terry steam turbines.

The boiler plant is equipped with recording flue gas thermometers, boiler feed water thermometers, and steam flow meters for each boiler, as well as a recording C02 meter and a Venturi meter on the boiler feed water.

In the engine room there are two York ammonia compressors of 75 and 40 ton capacity. To each of the machines is connected a York uniflow steam engine which operates condensing. The condensing equipment is a 1,000 sq. ft. condenser, with motor-driven air and condensate pump and motor-driven circulating water and booster pumps. A natural draft cooling tower with spray nozzles in the upper section is provided. Thirty-two stands of the flooded type of ammonia condensers and eight stands of distilled water coolers are placed directly under the tower.

Two freezing tanks, containing 1,600 300-lb. cans, are provided with compressed air hoists and vertical motor driven agitators. Water for ice making is taken from the condensate of the ice machine engines and the turbines of the electric plant and is boiled in a vacum type reboiler. Three charcoal filters and two cooling tanks are provided.

The day storage room has a capacity of 120 tons of ice, and directly over this room are located 8 cold storage vaults for commercial use. The vaults and the day storage are cooled by brine coils, the brine being supplied from either tank by motor-driven centrifugal pumps. An elevator is provided for the commercial vaults. Adjoining the day storage room is the season storage. The capacity of this room is 2,000 tons. It is cooled by direct expansion, the coils being placed on three sides and the ceiling. The insulation in all of the cold storage rooms consists of 5 in. corkboard with a mastic finish.

GRADES FOR ASPHALT PAVEMENTS AND PREVENTION OF CREEPING

By Monroe L. Patzig, Consulting Engineer, Des Moines, Iowa

Whether asphalt construction can safely be used upon the steeper grades does not depend upon creeping tendencies as much as is commonly believed.

To begin with, an asphalt mixture that will creep on level grades naturally will creep on steep grades. One that does not creep on level grades need not be expected to creep on steep grades when properly constructed. The creeping of this type of pavement on heavy grades is largely due to the inability to use proper construction methods, and for this reason we will consider matters tending to prevent creeping before the matter of grades.

I may say that the greater part of this creeping is caused by the lack of proper equipment and pains to prevent it. It is necessary for the purpose of bond, to have either a rough surface on the concrete base or a suitable bonding material between the concrete and the asphalt wearing surface. The reason for this is that a comparatively thin sheet of material is placed over the concrete. If there is no bond, temperature and traffic stresses will cause this sheet to move over the smooth concrete unless suitable bond be obtained otherwise. Methods other than roughened concrete have not been used to any great extent. One may think, therefore, that a thicker wearing surface, say from 5 to 6 inches, in thickness would not creep, and rightfully so. Such practice, however, is not followed at the present time and perhaps will not be on account of its higher cost.

I anticipate that some do not feel that this bond has so much to do with this trouble, yet it is my desire to impress this idea. It is so sometimes where the proper care has been exercised in preparing the surface mixture.

The mixture itself is many times, perhaps most of the time, responsible for this annoying defect. It may lack uniformity or proper design; one is as important as the other. Uniformity is essential from the raw materials to the finished rolling. Considerable variations in the asphalt cement cause non-uniformity. Carelessness in proportioning the mineral matter, rapid or large fluctuation in the temperatures, improper or irregular mixing of the materials, the dropping of unmixed aggregate or gobs of asphalt into the mixtures after they have been mixed, the lack of careful and uniform raking, and walking upon the freshly raked surfaces, are all important causes of trouble, and, last, but not least, is the pains taken in rolling the surface.

I wonder how many have ever figured out how little pressure is exerted on the surface even by a 10-ton tandem roller? Let us take for instance, a 10-ton roller with 2-3 of 20,000 lbs., or 13,333 lbs.,

spread over an area 60 ins. long by about 6 ins. wide or 360 sq. ins., this gives us only 40 lbs. per sq. in. The roller, or rollers, must work on the hot mixture immediately before it can possibly become chilled. All the rolling that is done after the surface once gets cold amounts to as much as that caused by a small boy on a pair of roller skates. Little does it seem to matter whether the roller be a large three-wheel roller or a smaller tandem roller. The rolling must be done while the material is hot and it must be done in such a manner that humps and depressions in the surface are rolled out.

There are those who insist upon rolling with a 10 to 15-ton 3-wheel roller, and this is all right so far as the additional compressive power is concerned, but without some cross rolling it is practically impossible to prevent a wavy surface. Furthermore, there is always a tendency with these big rollers to wait until the surface cools off. Much rests with the individual tendencies of the roller man, much more than with the roller.

As much might also be said of some of the other causes of non-uniformity, principally, however, of the operation at the mixing plant.

The contractors can do much along the line of remedying this situation by keeping their plants in better repair, or condition, at all times. They should install reliable thermometers of temperature controls, on various parts of their plants, and insist upon their men faithfully and continually carrying out their instructions which will produce good work. They must be more careful in their selection of raw materials and in combining them to secure the proper gradings. This requires more pains in purchasing the various grades of aggregate, proper proportions in their feed, and accurate weighing of the materials. The asphalt penetration must be kept more uniform than is often the case.

Just as important as the forgoing is the design or specification, for a poor mixture specified cannot make a good pavement if carried out.

There has been in the past much tempering with formulas or mixtures. It seems as though every engineer has attempted to specify a mixture different than some one else. Some of them are good, perhaps, but before results have been noted other mixtures have been substituted. This has been true especially with the asphaltic concrete types of pavements. Mixtures of asphalt dust, sand and rock in some cases up to ½ in. size, and others as large as 1½ in. It requires years to determine the soundness of any theories of mixtures and for this reason it is best to stick close to well tried formulas.

At the present time there is in progress an investigation of the cause and correction of shoving of asphalt pavements. In 1921 this investigation was undertaken by the Bureau of Public Roads, with the co-operation of the cities of New York (Boro of Manhattan), Philadelphia, Baltimore, Washington, and Detroit, and the Asphalt Association. No conclusions have as yet been drawn according to an article published in the 1921 Proceedings of the American Society for Municipal Improvements. A few extracts from this article may be of interest:

"In the first place shoving, or tendency to shove, is not an inherent characteristic of asphalt pavements, as evidenced by millions of square yards of satisfactory surfaces varying from one to forty years or more in age and subjected to all conceivable conditions of exposure and traffic."

"More often than not, when waves or deformations are noted in an asphalt pavement, most of the adjacent surface in the same line of travel and with the same exposure is found to be true to contour."

"Whatever the conditions are which make shoving possible, the primary cause of shoving is traffic, which produces a rearrangement of the mineral particles in the paving mixture to an appreciable depth from the surface down."

This article also goes on somewhat further regarding the effects of motor traffic.

To quote still further:

"Certain general conditions which tend to promote shoving by producing an unstable paving mixture are quite well understood, but it is believed that there may be much yet to be learned regarding the limits of such conditions. These and other conditions are listed below for the purpose of illustrating the complexity of the subject from a research standpoint."

Conditions Which Tend to Promote Shoving

Foundation Faults—1. Lack of support from below, causing local settlement of the foundation.

2. Uneven contour in foundation, causing variable thickness of asphalt paving mixture and consequent differences in compression.

3. Very smooth foundation which may promote slipping of the asphalt paving mixture over its surface.

Inferior Paving Mixture—4. Use of too soft an asphalt cement for the climate, traffic, or the grading of the mineral aggregate.

5. Use of too much asphalt cement in the paving mixture.

6. Poor grading of the mineral aggregate, which creates instability of the paving mixture irrespective of the consistency and percentage of asphalt cement with which it is mixed.

7. Use of an excess of rounded particles of mineral aggregate in the paving mixture.

Construction Faults—8. Uneven contour due to faulty spreading, raking, or rolling of the paving mixture during construction or lack of uniformity in the composition of the paving mixture.

9. Lack of proper initial compression during construction which may be due to use of too light a roller, too little rolling, to the mixture being too cold when rolled, or too great thickness of course for a single rolling operation.

10. Faulty repairs to service openings.

Exterior Causes—11. Absorption of an excess of oil or gasoline drippings, causing undue softening of the asphalt cement.

12. Gas leaks from mains below the pavement structure, causing undue softening of the asphalt cement.

The article goes on further to give details as to the selection of samples, collection of general information, specifications, paving plant and construction records, sampling and test records, and the tests to be made.

A suggestion was made by Mr. Dow that moisture coming up through the foundation into the underneath portion of the wearing surface is one of the most prolific causes of shoving. The writer is also of the opinion that non-uniformity of mixtures, causing fat spots or unbalanced gradings is of great importance.

One can realize, therefore, that there are many conditions to cope with to prevent creeping or shoving, but briefly, suitable foundations, uniformity and proper consistency of asphalt, careful proportioning of asphalt and various grades of mineral aggregate, careful treatment and mixing of the materials, and proper spreading and rolling, are the essentials to good construction.

Limiting Grades

Now, if the necessary pains have been exercised in preparing and laying the pavement, what are the limiting grades for asphalt pavements? Opinions on this matter differ greatly.

The results of a few recent inquiries as to the maximum grades deemed advisable for asphalt pavements, are interesting.

The City Engineer of Omaha, Neb., laid asphalt on a 15 per cent grade in 1922.

An engineer with considerable experience through the Eastern and Central States says that twelve per cent (12%) is considered about the maximum.

New Jersey limits the grades on this class of pavements to five per cent.

The writer has just recently examined a number of asphalt pavements on steep grades, the grades being 9 per cent, 10 per cent and 11.3 per cent. All of these have been in use for four years or more.

From the foregoing theories and facts, it is probably fair to say that the ability to secure proper construction or rolling limits the grade upon which it is safe to lay asphalt pavements. When it becomes impossible or impracticable to do the rolling properly the grade will be too steep.

It seems, therefore, that about 10% or 12% grades should be considered the limit for this type of construction.

Although a number of conditions have been cited tending to cause creeping of asphalt pavements, I have purposely emphasized the necessity of ample rolling of the surface. It is one of the requirements often, I might say nearly always, neglected and I feel that it has more to do with determining the maximum grade suitable to this class of paving than any other condition.

The foregoing paper by Mr. Patzig was presented at the recent annual meeting of the Iowa Engineering Society.

DUST SUPPRESSION ON GRAVEL AND MACADAM ROADS

By H. C. Smith, Michigan State Highway Laboratory, Ann Arbor, Mich.

Dust has ever been considered a nuisance on city or rural highways. The extent of the nuisance is dependent upon the density of traffic on the highway and the density of population and the valuation and character of property along the highway. Because of this relation, work in connection with the suppression of dust has been carried on much more extensively on city than on rural highways.

The desire of residents along city

streets to suppress dust has long been evidenced by the great amount of sprinkling and dust palliative work, as well as petitions for expensive pavements on streets, the traffic of which could be carried on less expensive pavements which, to be sure, are very dusty.

With the increase and change of character of traffic on rural highways and the higher valuation of property along the roads, all of which have tended to accentuate the dust nuisance, the highway builder finds himself confronted with the difficult but interesting problem of eradicating this nuisance.

Following the path of least resistance would dictate that we pave all roads with a dustless pavement as an effective and positive way of solving the problem, but the economics of the question will not permit of so careless a solution.

In these Central Western States where good material for gravel and macadam roads are found in abundance, and where the traffic on a very large mileage of our highway systems is such that it can be carried quite adequately on these types of highways, obviously and logically, this type of construction must be continued, forming an annual addition to the extensive systems of such roads already constructed on which the question of dust suppression is now recognized as a vital problem.

Although we might possibly justify the expense of this work on the grounds of eradicating a nuisance, we can retain the support of the public better and solve the problem more logically, if we at all times keep in mind the various advantages to be derived by the work.

The science of hygiene has established beyond the possibility of dispute that dust is decidedly injurious to health. Further, one need drive but little in dense traffic on a dusty road to be convinced that the dust causes a decided menace to safety, not only because of the lack of clear vision but also because of the natural tendencies of drivers to speed past one car after another in order to be rid of the dust. If needed, a citation of accidents on dusty roads which were clearly caused by the dust could be compiled readily to prove this contention.

At this point, it will be helpful to recall the fundamental principles of construction and maintenance of this class of highway. Essentially, a gravel or macadam road consists of an aggregate composed of fragments of stone or gravel sufficiently hard and tough to withstand the wear and blows of traffic, which fragments are cemented together by a cementing medium with a further stability in the macadam road due to the interlocking of fragments. Success cannot be expected in the case of either of these roads unless the materials required for the proper performing of these functions are at all times present. Inasmuch as the binding material in both cases is the fine material in the road crust, it is quite apparent that the removal of dust from the surface of the road injures the surface by reducing the amount of binder, and that the continued removal of this binder in great clouds of dust must necessarily be followed by a disintegration of the surface which shows up in the form of raveling of macadam roads, and of holes and also raveling of gravel roads. It is apparent, therefore, that dust suppression on gravel and macadam roads is necessary to convenience, health and safety of the traveling public, and also has a very marked tendency to preserve the compacted surface of the road which materially reduces the maintenance necessary to keep a good surface intact.

This item of saving is difficult of analysis in dollars and cents because of the variation in the traffic, the type of road in question, and the type of treatment used, but it is safe to say that this saving is sufficient to balance an appreciable amount of the cost of dust suppression in any case and in some cases quite to equal it.

Dust suppression on gravel and macadam roads is accomplished, either by the use of a bituminous surface or by the use of a dust palliative. For a macadam road, unquestionably, a bituminous surface is the most satisfactory practice, but on gravel roads, the dust palliative treatment is more common.

A bituminous surface consists of a thin superficial treatment of bituminous material, with or without the addition of pea gravel, sand, stone chips, or a combination thereof. Bituminous surfaces can be successfully applied on a macadam road using tar or asphalt, and the material is applied either cold or hot depending upon the consistency of the material used. Best results are accomplished by covering the bituminous material with a covering of stone metal of chips or gravel about ¼ to ⅝-in. in size. The amount of this material used should be sufficient to keep the bituminous material from remaining free to be picked up by the tires of vehicles, and yet should not be sufficient to

give a surplus of loose rolling stones on the road. Such a bituminous surface can be maintained for a series of years on a macadam road by retreating as it becomes necessary. At first such treatment is usually about 0.4 gal. per sq. yd. and retreatments about ¼ gal. per sq. yd.

It must be remembered in using a bituminous surface that this surface treatment cannot be used to correct irregularities in a poor surface but will effectively hold a good surface. It follows, therefore, that its use on a badly worn macadam road should be preceded by a thorough patching of the road to furnish a good surface. This patching can be done most satisfactorily with a mixture of broken stone and a bituminous material made especially for this patching work.

The success of a bituminous surface depends largely upon its adherence to the road and every precaution should be taken to accomplish this end. It is best, therefore, to construct such a surface on a road with a large exposure of flat surfaces of stone, as the bituminous material will adhere to these surfaces and hence be firmly connected to the road. All loose stone dust and foreign matter should be removed as a film of loose material will prevent the bituminous material from coming into contact with the stone surface which makes adhesion impossible. Finally, the surface must be dry, as a film of moisture also prevents adhesion.

In as much as effective retreatment of such a surface requires that a mosaic surface of large stone be uniformly present, each treatment should be uniformly applied so that a uniform exposure of the stone surface may be the result of the wear of traffic.

The problem of dust suppression on the gravel road has not been so easily solved. The conditions, in the case of the gravel road are not nearly so favorable for the use of a bituminous surface as in the case of macadam road. It is almost impossible to obtain a clean surface composed largely of a large surface of stones. This is due to the fact that the gravel road, composed of rounded particles, lacks interlocking and hence its stability is usually accomplished by a binder of fine material largely clay. This also makes it very difficult to secure a clean compacted surface inasmuch as the dust and fine material in the top surface of a gravel road, which is objectionable from the point of view of bituminous surface work, is the binding material for the top of the road. Bituminous surfaces, however, have been used in some states on gravel roads and it appears that the difficulties attending such work are most nearly eliminated by the following practice.

Where a bituminous surface is to be applied on a gravel road, the road should be shaped to the required cross-section and compacted. During the compaction under traffic, either with or without a roller, the ruts and holes should be kept filled so that a good even surface will result. The road should then be swept until it is free of dust and the bituminous material applied. Tar has been used most generally although some very satisfactory experimental work has been conducted with asphalt. About ½ gal. per sq. yd. is used for this treatment. A metal covering is then applied the same as in a bituminous surface on a macadam road. With this type of surface on a gravel road, it is necessary to adopt a patrol system of maintenance as holes in the road must be found and patched early, otherwise distintegration is rapid. This system of maintenance will depend on the type of gravel of which the road is built, and although it has been extensively used in some Eastern states its application in the Central Western states is new.

During the summer of 1921 the writer, under the direction of the Michigan State Highway Department, conducted a series of tests in connection with dust palliatives on gravel roads. In this series of tests, roads were selected throughout the state with a view to covering the normal of range of those major conditions which affect the dust nuisance on highways. Roads were, therefore, selected varying from light to heavy traffic, and varying from clean hard surfaces to surfaces covered with a great deal of loose material. So that comparative results of the various materials could be studied under like conditions, the same series of ten tests were conducted on each road. The series of tests consisted of the following:

Section A High Carbon Tar—¼ gal. per sq. yd.

Section B. No treatment.

Section C. Tar T-68—¼ gal. per sq. yd.

Section D Tar T-68—⅛ gal. per sq. yd.

Section E Light Oil—⅛ gal. per sq. yd.

Section F Heavy Oil—⅛ gal. per sq. yd.

Section G Cut-back Oil—¼ gal. per sq. yd.

Section H Cut-back Asphalt—¼ gal. per sq. yd.

Section I Flake Calcium Chloride.

Section J Granular Calcium Chloride.

In this series of tests, no endeavor was

made to obtain a bituminous surface and where one was obtained it was intended that it should uniformly disappear before the winter so the road could be carried through the winter and spring thaw period as a gravel road and the treatment repeated the following year if desirable.

As a result of this series of tests the following conclusions were drawn:

1. Any surface treatment of gravel roads for dust prevention should extend the full width of the traveled way rather than over a portion of the center of the road, such as 16 ft.

2. For general use as a dust palliative on Michigan gravel roads, calcium chloride is the most satisfactory from the point of view of general applicability, application by unskilled labor and adaptability to various types and conditions of road. It is impossible, based upon these service tests of one season, to reach conclusions as to its effectiveness and economy compared with other dust palliatives investigated.

3. No distinction can be made between granular and flake calcium chloride as to effectiveness.

4. Calcium chloride supplied in the 100 lb. bag containers is more economically handled than that supplied in the 350 lb. metal drum and it appears that it might be profitable for the necessary storage to be provided so that this economy could be realized.

5. The use of calcium chloride has a tendency to cause the surface to pit and become rough, which slightly increases the cost of blade maintenance above that of a similar road on which calcium chloride is not used.

6. It appears that a light oil such as that applied on section E can be used on a gravel road even under a traffic of 1,500 vehicles per day, in case there is a sufficient amount of loose material on the surface to absorb at least 75 per cent of the oil.

7. Where the light oil as applied on Section E is applied in a greater quantity than the loose material will absorb, it forms a thin glazed surface on the compacted portion of the road and the loose material which is quickly swept from the road cannot be successfully replaced as there is no tendency for material returned to the surface to adhere and become incorporated in the surface.

8. It is impossible, as yet, to standardize the use of light oil as a dust palliative for Michigan gravel roads because of the necessarily exact relation that should exist between the amount of oil applied and the amount of loose material. In no case should more than ⅛ gal. per sq. yd. be applied and the amount should vary with the amount of loose material on the surface.

9. The heavier bituminous materials used such as were applied on Sections A, C, D, F, G and H cannot be used for a dust preventive on Michigan gravel roads except as a material for forming a bituminous surface.

10. Regardless of the material used, a successful bituminous surface cannot be formed on a gravel road unless there is first a firm, even, hard surface on the gravel road which is free from loose material.

11. Bituminous surfaces formed within the limits of conclusion 10 and with the materials and amounts used in these tests, do not disappear uniformly.

12. It appears that bituminous treatments made without top dressing and expected to disappear annually, although apparently satisfactory during the summer months when used on a high type gravel surface, will leave the road in such shape that succeeding treatments will be impracticable unless the roadway surface is reconstructed, and furthermore will impair the quality of the surface if it is to be maintained thereafter as an untreated gravel road.

Further experimentation on calcium chloride work in Michigan and a study of its extensive use during the 1922 season, when the State Department contracted for 6,000 tons, has led to the conclusion that it will usually require three treatments to keep a road dustless throughout a season. The first application, ¾ to 1 lb. per sq. yd., is made as soon as the road becomes dusty in the spring, and additional applications of about ½ lb. per sq. yd. are made as it is required throughout the season. Where three such applications are made the annual cost will be approximately 3 cts per sq. yd, or about $320 per mile for an 18 ft. road.

The foregoing paper was presented at Road School recently held at Purdue University.

PROGRESSIVE CONSTRUCTION OF HIGHWAYS IN NORTH CAROLINA

By Charles M. Upham, State Highway Engineer, Raleigh, N. C.

If a state had an unlimited supply of money it would be a simple problem to

construct a state highway system, but practically all states are limited in the amount of money they have to spend in the construction of their road systems.

The function of a State Highway Commission is to provide a means of transportation for the state, and not the mere building of a few miles of hard surface roads and bridges at a few selected places throughout the state. For a state to develop as a whole, it is necessary that a connected system of highways should be available for the purpose of providing a means of transportation for the state's development.

Traffic is concerned with the roadway only to the extent of being provided with a smooth highway over which it may travel at a minimum of operation cost. The selection of the type of highway to construct is the problem of the engineer, after due consideration of all affecting elements, and should be a highway which will adequately and efficiently carry the traffic at a minimum maintenance expense.

It is absolutely essential that the road should be selected and so constructed that the money invested in the system of highways will at all times be a minimum. To best do this, means the construction of progressive type roads, in which all the standards of construction are the same, and by the use of which the lighter traffic is provided with a road suitable to its needs, and the heavier traffic with a hard surface road, which is the ultimate surface of all progressive type roads.

The solution of providing a means for traffic or the construction of a highway system in every state necessarily depends upon the local conditions in that state, and consequently, the method of solution will be different in the different states and depends on the economic, industrial, and social conditions throughout the state.

Practically every state in the Union has its cities and counties of high and intensive development, as well as its sparsely developed sections. To build immediately a system of hard surface roads throughout an entire state, when the demands for such roads are only within the highly developed sections, would be money wantonly wasted.

Within the highly developed sections, no doubt the construction of a hard surface pavement is the correct and only answer. In the urban and outlying districts, where the traffic is less intense, a lighter and less expensive road should be located, graded and drained upon the same standards customary with hard surface construction, so that when the country, through which the road passes, develops to the extent that traffic requires a heavy duty road, there will only be the necessity of adding the hard surface in order adequately to provide for the heavy traffic which may at some future time make demands on this highway. Still farther from the highly developed centers, and far out into the less developed country, there are still lesser traffic demands. Few vehicles and light loads generally constitute the pioneers in transportation. Quite often graded roads, with the proper drainage structures, constructed upon hard surface standards, will suitably take care of this rural traffic.

After the construction of the graded road provides a means to development, and the traffic demands become greater, a higher type surface, possibly a sand-clay, topsoil or gravel, can be added to the previously graded road, and when the locality still grows and the sections become more highly developed and the traffic demands are greater, there only remains for the road builder to surface these progressive roads with a hard surface. This will efficiently provide for the heavy traffic, which ultimately makes demands on the roads in the developed localities.

North Carolina has three distinct geographical divisions. The mountain section is made up of farming and mining sections with numerous resorts so located as to take advantage of the wonderful scenery; the piedmont section or foothills, with its farms and industries highly developed; and the flat coastal plain, with its excellent farms and industries claiming great attention for their transportation needs. These three great geographical divisions are divided into 100 counties, and many more centers of population. It is the work of the State Highway Commission to connect these centers with a highway system or a means of transportation which will adequately provide for the class of traffic which now exists and is expected in the near future. The problem of selecting the type of progressive road is somewhat reduced when it is seen that hard surface roads are immediately required efficiently and economically to care for traffic demands in connecting the developed industrial centers. This is also true in the highly developed farming sections. The remainder of the problem is to provide suitable and continuous roads to connect up the cen-

ters in a manner which will satisfactorily provide for the needs of transportation, at the same time keeping the money investment always at a minimum.

The distances are long and it is practically always the fact that the state's development and the intensity of traffic will not justify the construction of hard surface roads throughout the entire system. The answer to the problem of providing the state with a means of transportation lies in the construction of progressive type roads so constructed on high standards that they may be ultimately turned into hard surface roads by the addition of a higher type standard surface.

The North Carolina method of progressive type construction is to grade the road, using the same standards for line and grade that are used in hard surface construction. Only one standard of drainage structures is used regardless of whether the road is merely graded or is to be covered with a hard surface. This construction of graded road will care for the light traffic which generally exists in all newly developed localities. This graded road is at all times maintained and when the increased traffic creates a high cost of maintenance, then it is indicated that it is time to construct the next higher type of road surface. The next step in the progressive type road is to cover the graded road with a selected soil material, such as sand-clay, topsoil or gravel. This material is generally of higher bearing value than the natural soil, and is a material which is less affected by moisture and therefore more suitable for use as a road surface. This selected surface material is maintained as a subgrade highway until such time as the maintenance cost becomes excessive and the increased traffic indicates that a hard surface roadway is necessary.

The cost of grading and the drainage structures generally constitutes about one-sixth of the ultimate cost of a hard surface road. To add a selected soil surface adds very little difference to the cost of this construction; consequently about six times as much road, with a selected soil surface, may be constructetd for the same money as though the money was spent for the immediate construction of hard surface roads. This makes it possible for transportation to be benefited to a much greater extent and the state to develop at six points rather than in one.

It will be noted that the construction of the selected soil surface is an addition to the graded road, and no previous step in the grading or construction of drainage structures has been lost or thrown away in the construction of this selected soil surface road.

In the progressive type road all steps taken in its construction include the utilization of all previous construction when transforming the road to the next higher type, and each step may be considered as a subgrade for the next higher type surface. This in itself justifies the expenditure of a sufficient amount of money to select soils of a character which may, with proper maintenance, be used as a surface material until such a time as traffic demands, or the cost of maintenance makes it necessary to construct the next higher type of hard surface. By this method of contruction the graded road or the selected soil surface can truly be called a subgrade highway, and is often the economic solution for road construction over a large portion of a state system.

The ultimate step in progressive type construction is the addition of the hard surface. After the maintenance on the selected soil surface becomes excessive or when the country and traffic develop to the extent that a hard surface road is necessary, the next step is to construct the hard surface pavement directly on the selected soil surface. This method of progressive construction utilizes advantageously the selected soil surface as a stabilized subgrade for the hard surface pavement, and on account of the complete settlement, and on account of the character of the selected soil surface, the subgrade is stabilized sufficiently to aid the hard surface in carrying the loads.

Therefore it may be seen that the construction of the progressive type road, light traffic or a small tonnage is cared for by a graded road of comparatively low cost. As the traffic demands and tonnage increases, the road is increased in strength, and the increase of the investment is justified. As the traffic and tonnage increase to the maximum, a hard surface road is constructed. The construction of roads on progressive principles means that the greatest percentage of the invested money is in permanent construction, and justifies the expenditure of bond money in any progressive type road.

North Carolina has constructed many progressive type roads. It has already completed its cycle by placing hard surfaces on roads which were previously graded and stabilized with a selected soil

material, although at present it has a reasonable mileage of graded roads in the newly developed localities; it is maintaining as subgrade highways a large mileage of selected soil roads and thus affording a means of traffic to a great portion of the state. The completion of about 400 miles of hard surface construction in 1922, many miles of which was hard surface, added to progressive type roads, demonstrates the complete and satisfactory manner in which the progressive type road is caring for the traffic in North Carolina and shows that this method of road construction is no longer in the experimental stage, but that this means of constructing a highway system is economically and practically sound and is highly recommended where the geographical, industrial, social and economic conditions are as found in North Carolina.

The foregoing paper by Mr. Upham was presented at the recent annual meeting of the American Road Builders' Association.

PROBLEMS IN HIGHWAY BRIDGE ECONOMICS

By Lewis M. Gram, Professor of Structural Engineering, University of Michigan, Ann Arbor, Mich.

The function of an engineer in construction work is to solve his problems so that adequate service will be rendered at minimum cost. This is a basic principle easy to state, but difficult to carry out with any degree of uniformity, because just what constitutes "adequate service at minimum cost" is a matter of judgment, which in turn involves differences of opinion. Furthermore, engineering problems relating to highway bridges cannot be entirely disconnected from similar problems relating to the adjacent roadway. The best solution of a bridge problem might not be so for the adjacent roadway, and vice versa. The effect of each upon the other in particular cases should be carefully considered, and to a certain extent it is one problem instead of two, having in mind the best interests of the highway as a whole.

Permanency of Structure

Obviously the study of all highway bridge problems from a broad economic viewpoint involves the probable permanency of the structure; and it is to that particular phase of the subject that this discussion will relate. Again, it must be remembered that bridges are integral parts of the highway, and as such the extent of their future usefulness is subject to the same uncertainties that surround our highway transportational facilities in general. Difficult, however, as it may be to forecast all of the conditions affecting the useful life period of the roadway portions of a highway system, there are many reasons why the problem relating to bridges is even more complex. From their very nature bridges have to perform a two-fold service, that which is incidental to the passage underneath, as well as that which is required by the traffic over them. Hence radical changes in either respect from the conditions for which any particular structure was designed will affect the useful life period of the bridge. Although a fixed bridge, by which is meant one that has no moving mechanism, does not wear out to any greater extent than the roadway surface which represents a small cost compared to that of the bridge as a whole, the materials in the bridge proper may disintegrate more rapidly than those in the roadway. Repairs or reconstruction may be long deferred in a roadway while weak spots in a bridge require immediate attention.

Useful Life Period

As a purely business proposition the probable permanency of a structure is a question that should be taken into account, together with that of initial cost. It would be poor policy indeed to buy a structure of low original cost, but which required expensive repairs soon after its completion, or which would have to be replaced at a comparatively early date. Unfortunately, however, the useful life period of a structure involves so many uncertainties that it cannot be definitely anticipated. Perhaps the best we can do is to base our judgment of the future upon the past, although the disappointing thing about such a procedure has been to find, as each year's developments passed into history, that our most liberal expectations for that particular period have been far exceeded. In the light of historical data the outstanding factors affecting the useful life period of a bridge are:

First—The relation between the capacity for which the structure is designed and that which may later be required.

Second—The deterioration of materials of which the structure is built.

Other circumstances affecting the permanency of bridges, such as relocation of a section of highway or radical change in profile for the purpose of reducing grades, do not fall within the intended scope of this discussion. Unfortunately from the standpoint of attractiveness of our public

structures, the appearance of a bridge has little influence upon its permanency, and a structure unsightly when built must be endured until for some more practical reason it is discarded.

Capacity

With reference to capacity, the life period of the structure can be partially controlled by the designer depending upon how liberally he provides for future requirements. Just what might be considered reasonable liberality in the matter of future increases in traffic, however, is clearly a matter of opinion, and it is not unlikely that designs based upon them will fall as wide of the mark in the future as in the past. For the purpose not of offering an explanation for the inexcusable lack of foresight on the part of the designers in special cases, but rather to demonstrate what little chance a real prophet of a decade ago would have had in convincing the average road commissioners of the accuracy of his vision regarding highway usage, some statistics relating to the growth in volume of highway transportation are pertinent. The registration of motor vehicles in the United States, by which is meant both passenger cars and motor trucks, increased from 1,033,096 in 1912 to 10,448,632 in 1921, or over 1,000 per cent; the registration of vehicles in two states alone in 1921, namely, New York and Michigan, exceeded by 222,700 the total registration in the United States in 1912; and the increase in registration of 1921 over 1920 in the United States, despite a poor year for motor vehicle production, also exceeded the total number of vehicles in 1912. With these facts before us, it is no wonder that many bridges constructed ten years ago with allowances for future increases in traffic, which were then considered reasonable by the designer, are inadequate today. The surprising thing about it is that so many bridges have survived. A comparison of the volume of motor traffic of today with that of twenty years ago shows an even more startling development. Because of lack of registration we do not have at hand accurate figures regarding the number of vehicles for that early period, but such production records as are available indicate practically no motor trucks and less than 5,000 passenger cars.

Volume and Weight of Traffic.

To add to the difficulty of making the roadway fit the traffic, motor vehicles are unlimited in their field of action. Unlike the structures of a railway, which are designed to meet the needs on particular systems, the highways are public and may be used by whoever desires to do so. Scientists tell us that certain insects which multiply with slightly greater rapidity than motor vehicles, do not wander far from their place of birth. It is not so with motor vehicles. We in Ann Arbor are accustomed to see quite a sprinkling of vehicles from foreign states, occasionally as remote as Florida and California. A good road to an objective point, however distant, advertises itself with remarkably prompt and voluminous results. All of which adds further to the uncertainty of just what the future requirements in any particular locality will be.

Furthermore, the above statistics refer to increases in volume of traffic, which is only half the story, as the capacity of a highway may be expressed in terms of either volume or weight of traffic. In passing, it might be noted that inadequacy of bridges with respect to volume of traffic has been more acute in recent years than with respect to weight. This is explained by the fact that the margin of excess usually provided in the design of highway bridges is greater for weight than for volume of traffic. A two-way structure is never more than that, while increases in service loads are always permissible in properly designed structures. In some respects this is a fortunate situation, inasmuch as inadequate volume capacity of a structure means simply throttled traffic involving moderate danger and delay, while failure under excessive load may result in fatalities and prolonged tie-up of miles of a highway system.

While the story of motor transportation reads almost like a fairy tale, it has its parallel in what has been done in a corresponding period in the development of good roads. In fact, it is impossible to estimate the extent to which each has contributed respectively to cause and effect. The users of motor cars are numerous and influential enough to bring about road improvement. Road improvement in turn stimulates the use of motor vehicles, and thus we have the one always chasing the other in an endless cycle, as it were. Just when one will catch up to the other is of course impossible to tell, but naturally road improvement and motor car production will go hand in hand with abnormal speed until traffic on the highways reaches its economic level in the whole field of transportation.

As an important detail in the process

of road development, to which reference has been made, highway bridges have occupied a peculiar economic position. Per foot of highway the average bridge is a comparatively expensive part of highway construction. Naturally, therefore, the cost of bridges is always reduced to a minimum consistent with service requirements. In the days of horse-drawn vehicles a country bridge was considered of ample volume capacity if wide enough for two ordinary vehicles to pass at slow speed, or say a minimum of 14 ft., and high enough, if there was overhead construction, to permit the passing through of a load of hay or a threshing machine. If perchance two vehicles should meet at a bridge and one be required to wait until the other one had passed over, the value of time in transit was not sufficiently great even to cause serious mental irritation. Nowadays the situation is vastly different. With the advent of swiftly moving vehicles, transit time has taken on new standards eof value and traffic interruptions are more serious. The loss of time thereby may have real or fancied value, but in either case pressure is properly brought to bear to remove the throttle.

Aside from the more or less serious delays referred to, there are other good reasons which tend to terminate the usefulness of many structures long before the materials with which they are constructed have dangerously deteriorated. A bridge which is inadequate with respect to volume of traffic is likely to be a real menace to rapid highway transit, in that it contributes to many accidents either by collision with portions of the structure which project above the roadway, precipitation over high banks or both. It must be borne in mind that many drivers of highway vehicles are unfamiliar with the roads over which they are traveling, and it goes without saying that in the interest of safety to the general public every reasonable precaution should be taken to minimize hazards.

The Waterway

Another feature of inadequancy in the design of bridges, often resulting in serious damage and sometimes to the extent of complete failure, is with respect to the waterway. Major defects, such as scant opening for the flow under flood conditions or shallow bearing on the soil, will directly endanger the piers and abutments; and stability of the superstructure being dependent of course upon that of the substructure, it is doubly important that every detail of the foundations be carefully studied and liberally designed.

In discussing the permanency of bridges from the standpoint of deterioration of the materials of which they are constructed, we are standing on firmer ground. That is to say, the situation is not complexed by such uncontrollable factors as the development of vehicular traffic. The useful life period of a bridge, insofar as the materials are concerned, is largely dependent, first, upon the kinds of materials used in construction and, second, upon the places where used and the care which is given in maintenance.

Life of Timber

As a matter of common knowledge for example, timber when alternately wet and dry will decay in a few years, and the only way to preserve it indefinitely is to keep it in either one condition or the other all the time. Practically it is easier to keep timber saturated with water than perfectly dry and in substructure work sound timber, which is always submerged in fresh water, may be considered absolutely permanent. Samples taken from the timber in the substructure of the Belle Isle bridge, after about 30 years' submersion, showed absolutely no deterioration. Other similar observances are on record. The critical zone for timber in substructure work is adjacent to the water line, where the material is naturally subjected to alternately wet and dry conditions. Timber piles and grillages, as frequently used in the foundations for bridges, bear silent witness to that fact.

It is practically impossible on the other hand to prevent timber which is used in the superstructure of bridges from being wet or dry intermittently. Paint and various impregnating processes will go a long way toward preservation, although sooner or later decay is likely to get started at inaccessible joints. Complete housing is the only effective way to make the timber superstructure of a bridge reasonably permanent, but this is obviously an expensive expedient in the matter of first cost, as well as in maintenance of the housing itself. The average lifetime of timber bridges, insofar as the decay of the material in the superstructure is concerned, may be estimated at from 12 to 15 years when exposed to the weather, notwithstanding the fact that in some cases they have been continued in service by careful maintenance for over 50 years. When thoroughly protected from the

weather by housing, timber bridges may last indefinitely with comparatively inexpensive maintenance costs on the bridge proper. There are in fact examples of enclosed timber structures built nearly a century ago which are still in service, to the discredit of so-called "permanent" bridges in their immediate vicinity. Danger of complete destruction by fire is always a hazard which cannot be avoided in a timber structure, and unquestionably this fact had much to do with causing metal structures to become popular long before they compared favorably with timber bridges in the matter of cost.

Life of Metal Bridges

Steel and wrought iron bridges would be absolutely permanent with respect to deterioration of materials if, as in the case also of timber bridges, the conditions to which they were exposed were ideal. Steel and iron, however, will slowly decay through oxidation or rusting whenever they come directly in contact with air and moisture. This action is sometimes referred to as a slow fire. Various chemicals and gases and stray electric currents tend to accelerate the oxidation. When submerged in water the rusting process progresses more slowly, depending upon the extent to which the water is aerated. The best way, therefore, of guarding deterioration of steel and iron in our bridges is to prevent direct contact with air and moisture; and a film of paint is usually employed for that purpose. The practical difficulties in the way of perfect protection to the metal in a bridge by such method, however, are well known to those who are familiar with maintenance problems. Even though paint is applied at reasonably frequent intervals, there are many inaccessible places where decay is inevitable and cannot be checked. Under ordinary conditions of exposure the most vulnerable points for the disintegrating influences are at pin and riveted connections.

With reasonable care in maintenance, however, the materials in a metal bridge are likely to be in serviceable condition when the structure has outlived its usefulness in any particular locality for other reasons. Wrought iron is less susceptible to corrosive action than steel, and as evidence of the durability of wrought iron bridges, there is an arch bridge of that material built in 1835, near Pittsburgh, which is still in service and in excellent condition from a corrosive resistance standpoint.

Strange to say, there are cases on record where metal bridges have been completely destroyed as a result of fire in the wooden floor or paving. In 1915 nine through spans and half of the draw span of the old Belle Isle bridge in Detroit were completely destroyed in that manner almost before the fire apparatus could arrive on the scene.

Useful Life of Concrete Bridges

Concrete and reinforced concrete is popularly conceived to be an absolutely permanent material without maintenance, but an examination of many existing concrete bridges or other outdoor concrete structures will demonstrate that such an impression is not unqualifiedly true. For various reasons which will not be referred to here except to say that sometimes they are decidedly obscure, concrete as placed in our bridges has a wide range in quality, and if in speaking of the absolute permanency of concrete, material properly designed, carefully mixed and placed is meant, the statement is doubtless warranted. If on the other hand the material is defective, either with respect to design or fabrication, it will fall far short of absolute permanency. As well expressed by Professor McKibben, the owner of a concrete structure should not be led to believe that in every case he will have something as enduring as Verdi's "Il Trovatore," or Dante's "Divine Commedia." Many outdoor concrete structures do in fact show positive deterioration after 5, 10 or 15 years of exposure. There is especial danger when moisture can reach steel reinforcement as the formation of rust sets up a tremendous pressure and usually results in spalling off of the surrounding concrete. It is only fair to add in behalf of good concrete as a bridge material that it will increase in strength as it ages. The ultimate strength in compression at the end of a year is about 50 per cent higher than at 30 days, when it should have ample strength to develop the stresses assumed in design. Furthermore, the weight of a concrete structure is so great in proportion to that of the traffic that large increases in weight will have a relatively small influence upon the intensities of stresses in the concrete. These facts are of distinct advantage for concrete, considering the future weight adequacy of structures in which it is used.

Summary

The factors which have to do with the useful life period of any particular structure may be broadly summarized into three points:

First—Materials.
Second—Design.
Third—Maintenance.

There are proper places in highway bridge construction for the use of each of the three kinds of materials herein discussed—timber, steel and concrete. Their advantages and disadvantages respectively are well known through observation and experimental investigations, and with data at hand relative to comparative prices the designer is enabled to make a choice which will properly meet the requirements in any particular case.

Under design is the presumption that the materials, regardless of kind, will be economically and yet wisely proportioned. Full consideration should be given to the historical fact that inadequacy, either with respect to volume or weight of traffic, rather than deterioration of materials of construction, has been the prevailing cause of premature abandonment of highway structures. The designer should always keep in mind the probability of required strengthening, or expansion of a structure before the materials have outlived their usefulness. Details especially should be liberally proportioned. Comparatively little expense may be added by excess material at critical points, and yet minor weaknesses may develop into a case of the tail wagging the dog in the matter of prolonged serviceability of the structure as a whole. The general type of structure selected has an important bearing on the practicability of volume expansion, in case the growth of traffic requires either a new bridge or an increase in width of the old one. If any structural portions of a bridge extend above the roadway it is in general impracticable to adopt the latter expedient, while a deck structure can usually be extended indefinitely in a lateral direction without interfering with a clear roadway. The deck arch type is particularly advantageous because of its expansiveness as well as appearance, and because of the temptation to use it quite generally for highway bridges, a word of caution should be expressed, that is to make sure that the foundation conditions, which have so much to do with the integrity of the arch type, are favorable for it.

In the final analysis the useful life period of a bridge, insofar as it may be affected by decay of the materials, depends upon maintenance and repair. Careful and systematic inspection, followed up by prompt attention to such defects as may appear from time to time, is bound to result in prolonging the life of a bridge, whatever the materials of construction may be. Private corporations, and especially railway companies, are keenly sensitive to the value of thorough maintenance, probably for the reason that the benefits of longer structural life and uninterrupted service show up in the dividends. It is a notable fact that most steel and iron railway bridges replaced by reason of inadequate capacity are practically as good as new, insofar as the materials are concerned. Highway bridges, on the other hand, are too often sadly neglected, painting too long deferred, shoe pockets allowed to fill up with dirt and vegetable matter, with the inevitable result that the life of many structures is unduly shortened. For reasons pointed out there are some elements in the design of highway bridges which are pardonably misjudged, but there is absolutely no good excuse for careless inspection and maintenance. Whatever materials may be used in constructing a bridge, and whatever volume and weight of traffic it may have been designed to carry, there is no better and certainly no cheaper elixir of life than reasonable care and attention.

The foregoing paper was presented at the Ninth Annual Michigan Conference on Highway Engineering at the University of Michigan.

DEVELOPMENTS IN BITUMINOUS PAVEMENT MAINTENANCE

By B. C. Tiney, Assistant Maintenance Engineer, Michigan State Highway Department, Lansing, Mich.

Although strict adherence to my subject would confine this discussion to bituminous pavements, I have included waterbound macadam, as this is a type of surface upon which bituminous materials are used extensively in maintenance.

Between 1½ and 2 million gal. of tar and asphalt are used annually for the maintenance of roads in Michigan. Approximately 85 per cent of this is applied as a surface treatment on water-bound and bituminous macadam roads.

Motor Pressure Distributors

Modern mechanical devices for preparing these surfaces for treatment and for spreading stone chips upon the surfaces, have been developed. Bituminous materials are quite generally applied by motor pressure distributors of various types. The pressure is usually afforded directly

by a pump, operated by a power take-off from the transmission of the truck or in a few instances, by a separate power plant. A powerful truck motor is required if it is to assume the additional work of pump operation. The pump is so designed that it can be used for filling the distributor from tank cars as well as applying material to the road surface. A cut-out may be so arranged that the exhaust from the motor comes in contact with the pump, and by warming the material, increases fluidity and ease of pumping.

It is important that distributors be equipped with heating arrangements. Even though the material is brought to the required temperature in the tank cars, a long haul or other delay will often necessitate re-heating on the road. Heating equipment may consist of oil-burners or steam coils. Steam is, in one type of distributor, generated by a small boiler on the rear of the truck, but it is more commonly supplied from an outside source, which is not always conveniently located. The advantage of a self-contained source of heat is obvious as it permits of heating during a long haul so that the material arrives on the road ready for application.

Spraying manifolds are so designed that any width of treatment from 2 to 16 ft. may be applied, but common practice confines the application to about 8 ft. or half the width of roadway, at one time, as this enables traffic to avoid the freshly laid material.

Distributors should be equipped with thermometer, pressure gauge, and speedometer. The tank should be calibrated in order that the correct gallonage may be charged to each road. The rate of application is varied by setting of valves and by the speed of the truck. A table showing the quantities applied per sq. yd. for different valve settings and truck speeds should be posted in the cab for use of operator.

Use of County Forces and Equipment

Until recently, the distributor service afforded by the bituminous materials companies has been largely employed by counties in this state. This service, while very commendable in some respects, had certain draw-backs. Many counties required service at the same time and the companies found it difficult to arrange a schedule which would give every road a treatment at the proper time. A macadam road, upon which a necessary treatment is deferred, soon begins to ravel and requires hand patching.

The work being widely scattered, required that distributors be moved long distances at considerable expense. The labor gangs employed by the companies to prepare surfaces and spread stone coverings, were compelled to remain idle at times, due to unfavorable weather conditions or delay in shipment of materials, and this increased the overhead cost to the companies.

It was believed that conditions might be bettered and the work placed upon a more economic basis if performed directly by use of county forces and equipment. With this in view, five counties purchased distributors in 1922. These machines were mounted on army trucks furnished through the State Highway Department at a nominal cost.

Analysis of Costs in One County

The plan has, in all cases, proven very satisfactory. The quality of work performed has been excellent, and a material saving in cost has been effected. An analysis of costs in one of these counties for the season of 1922 is as follows: Twenty-four roads, aggregating 408,000 sq. yds. were treated with 135,000 gals. of tar, averaging a little less than 1-3 gal. per sq. yd. Tar cost 9.4 cts. per gal. f. o. b. county in tank cars. Slag cover, costing $2.25 to $2.50 per ton f. o. b. cars in county was distributed in piles by motor trucks. Labor was 35 cts. per hour.

AVERAGE ITEMIZED COST PER SQUARE YARD

Slag, in piles along road	$0.016
.....	0.031
Application of tar	0.005
Preparing surface and spreading slag	0.008
Tar f. o. b. railroad siding	
Gasoline, oil and overhead	0.006
Total cost per square yard	$0.066

A portion of this material was applied hot. The costs given include a rental charge on equipment used.

The contract price in this county in 1921 for a treatment of 1-3 gal. per sq. yd. was $0.113. On this basis we have a saving of $0.047 per sq. yd. on 408,000 sq. yds., or approximately $19,000. About $4,000 of this amount is due to a reduction in the price of tar, leaving a saving of $15,000 which is chargeable to the performance of work by use of county forces and equipment.

Similar results have been the experience of other counties operating their own distributors, and it is believed that

this plan will come into more general use. The installation of permanent tanks for storage of bituminous materials would add to the efficiency of the system. Demurrage and tank-car rental, which amount to considerable sums if weather conditions are unfavorable, would be practically eliminated. The shipment of material is likely to be, at best, an erratic proposition. Storage facilities would tend to co-ordinate shipment with application of material, enabling the work of distribution to proceed more steadily.

It is often possible to install storage tanks at such elevation as to permit of unloading from tank cars by gravity. Tanks should be of sufficient size to hold one carload (approximately 10,000 gals.) of material, and should be equipped with steam coils or other arrangements for heating.

Patching

In addition to regular surface treatments at intervals of from one to three years, depending upon the amount of traffic, it is neccessary that bituminous macadam surfaces be patrolled frequently and small holes patched soon after they appear. The importance of this feature of the work is usually under-rated, but it is one of the answers to successful maintenance. Shallow breaks in the surface crust may be swept clean, given a brush coat of bituminous surfacing material and covered with a layer of stone chips. A brush coat is preferable to a poured treatment as it avoids an excess of material, which is very undesirable. The practice of patching holes greater than ½ to ¾ in. in depth by pouring partly full of a cold bituminous surfacing material and covering with an excess of chips, has been quite common and is to be discouraged. It is obvious that such patches will remain unstable for some time and a large per cent of them will be displaced by traffic. Patrol maintenance on shallow patches may be conveniently handled by storing bituminous surfacing material in barrels sunk in the ground at intervals along the road. These barrels are provided with covers and are readily filled by a hose from the distributor tank. Piles of stone chips are also stored at necessary intervals. A patrolman equipped with a wheelbarrow, bucket, broom and shovel is enabled to patrol a maintenance section very efficiently.

Holes of an inch or more in depth may be conveniently repaired by the cold patch method, being tamped full of a cold mixture of aggregate with cut-back tar or asphalt, which depends for its setting-up qualities, upon the evaporation of volatile oils.

The stone for this mixture may range in size from ¼ to ¾ in., fractured shapes being preferable to rounded pebbles. The quality of the aggregate is a large factor in the success of any bituminous mixture, and it is often found to be economy to ship in a hard tough stone at additional cost, rather than use a cheaper local material of inferior quality.

The mixture should be made in the proportion of 16 or 18 gals. of bituminous material to a cubic yard of stone. A small amount of coarse sand may be added, but is not essential to good results. An excess of either sand or bituminous material will tend to make the patch unstable.

It is found that the patches offer more resistance to displacement by traffic if the mixture is allowed to cure for a few days before placing in the road, and also, in case of the deeper holes, if a larger stone is used in the bottom layer of the patch, being surfaced with the finer mixture. The hole to be patched should be swept clean and painted lightly with bituminous material before tamping in the mixture. A light sanding of the surface prevents adhesion to traffic while curing.

Mixing Stations

Where considerable quantities of cold-patch are used, the mixing is most efficiently performed by means of a small concrete mixer. This may be housed in a building of sufficient size to provide space for mixing and storage of materials. The design of the building should be such that a motor-truck may be driven into it and at least a part of the materials handled mechanically.

A number of such mixing stations placed at central locations for given maintenance sections, could be constructed on standard plans, so that one mixer could be readily moved by truck and made to do service for all stations. In this way a supply of mixture might be kept on hand and curing at each station.

A hundred miles of bituminous surfaced road, for example, might be divided into four 25-mile sections, each having a central mixing station so that the average haul of mixed material would be only 6 or 7 miles. This condition would, of course be ideal, the work being, in general, more scattered, but it is believed that in most cases a satisfactory arrangement could be worked out. Such a system has been in practice in Lucas County, Ohio, for the

past 5 or 6 years and has proven very efficient. The mixing stations here are used also for storage of equipment and as headquarters for other kinds of maintenance work.

Using Bituminous Macadam

Extensive replacements of bituminous surfaces are often made with bituminous macadam, by the penetration method. Two sections of a certain trunk-line of this state have, within the past four years. furnished notable examples of road failures. They were quite widely separated, but had many characteristics in common, the construction of both being a Topeka surface on a cement-concrete base. The failures were caused by a combination of heavy traffic, poorly-drained subgrade, and insufficient thickness of base. The maintenance of these roads presented a difficult problem. Both were main arteries, carrying an average daily traffic of 2,500 to 4,000 vehicles, many of which were heavily loaded trucks, and it was imperative that extensive replacements be made with as little inconvenience to traffic as possible.

This consideration led to the choice of bituminous macadam for replacement, as these patches could be placed under traffic almost as soon as they were finished. The general method of procedure was to remove sections of the broken pavement and the subgrade to a depth of at least 11 ins. below finished grade, or deeper if necessary to obtain a firm foundation for the new work. It was often found necessary to go to a depth of 18 to 24 ins. The lower portion of the patch was constructed of macadam in 4-in. layers, compacted by a roller, if the patch was large enough to permit a roller to work, otherwise being hand-tamped. In the case of some of the larger patches, the upper layer of this macadam base was waterbound, but in most instances it was merely dry-filled with screenings. The surface course of bituminous macadam was then placed to such height that it rolled down flush with the finished grade of the old pavement. None of these patches has ever failed under traffic, some having been in place for three years, being given surface treatment maintenance.

This work is rather expensive, costing from $5 to $7 per sqare yard, but the conditions were abnormal, and any type of replacement would have been very costly. Had it been possible to have closed the roads to traffic, a saving of at least 25 per cent would have been effected. It is thought that these roads may, ultimately, be rebuilt with a heavy macadam base and a high-type surface, in which event many of the large patches will have a salvage value. In fact, 4½ miles of one section has been reconstructed, using a three-course water-bound macadam, 12 to 15 ins. thick, which is at present carrying traffic on a surface treatment. The idea in this case is to let the macadam season under traffic for a time before placing a high-type surface.

Maintaining Asphaltic Concrete and Sheet Asphalt

The maintenance of asphaltic concrete or sheet asphalt surfaces in locations where an asphalt plant is not accessible is often carried on by the use of small portable plants wherein the asphalt and aggregate are heated in separate compartments and the mixing is done by hand. A gang of four men using one of these plants can mix and lay from 30 to 60 sq. yds. of surface daily. A roller is not required on these small patches, as they may be compressed by hand-tamping with hot irons.

In relieving ruts and depressions in an old asphaltic pavement by the addition of fresh mixture, the new material may be bonded to the old by first softening the latter with a surface heater. The heat is applied by oil-burners and confined to the pavement by a hood. Care must be taken to avoid burning the old material, although no flame comes in contact with it.

Using Old Asphalt

Old material taken from an asphaltic pavement may sometimes be re-heated and used again. This plan is used a great deal in the winter maintenance of asphaltic streets in the city of Cincinnati. The old pavement is broken into pieces about 2½ ins. in size and placed in four-wheeled kettles of 100 gals. capacity. About 4 or 5 gals. of water are added, the kettle is covered and the mixture allowed to steam for about one-half hour. The material is then turned over with heavy bars and spaded. Allowing time to steam, the mixture is turned and spaded several times until the water is all evaporated and the temperature raised to about 325 deg. F. The kettles are then hauled to the street and the mixture tamped into the holes.

Central Purchasing

Prior to 1922 the bituminous materials used for maintenance of state and county roads in Michigan were purchased individually by counties under the trade names of the various producers. The State Highway Department, in participat-

ing in the cost of trunk line maintenance, found but little uniformity in the price or quality of materials used for the same purpose in different counties.

In 1922 the state introduced the idea of centralized purchase of these materials on standard specifications. Acting in behalf of counties, the state received competitive bids on estimated quantities. A tabulation of all bids was sent to each county, together with recommendations as to choice of materials. The counties then executed contracts on standard forms furnished by the department. Arrangements were made for laboratory control of the materials by the State Highway Testing Laboratory. This plan resulted in a material reduction in price, more uniform quality of materials and better service. The state and counties are unanimous in their desire to continue this arrangement, with a few minor changes in 1923.

Use of Tars

Specifications used for tars for surface treatment were those published by the A. S. T. M. in their Tentative Standards of 1921. These embrace four different specifications covering high and low carbon tars for both hot and cold application. Practice in this country has not established any decided preference for either high or low carbon tars. In England the refining of tars for road work dates back to 1834, and at a recent conference of engineers in that country, high carbon tars were much favored on the ground that the presence of approximately 25 per cent of free carbon rendered the tar more viscous and less susceptible to temperature changes. On the other hand, there is good reason to believe that carbon, being an inert material, simply dilutes the tar and reduces its cementing value. The fact remains that good results have been obtained in this state with both high and low carbon tars.

Cold application tars are generally preferred for surface treatment work in Michigan, but the practice of heating these slightly to facilitate application is becoming more common, especially if a very light treatment is desired.

Specifications used for surface treatment asphalts were those published by the United States Bureau of Public Roads in their Bulletin 691, under designation of OH-1 and OC-2. These provide materials for both hot and cold application. Our general observation has been that better results may be obtained with the cold application asphalts by heating them slightly. The tendency with the hot application materials, unless carefully handled, is to produce a heavy mat which will push under traffic. If laid on new work they should be preceded by a priming coat of lighter material.

Standard specifications of the Michigan State Highway Department covered materials for bituminous macadam. Companies were asked to bid on their own specifications for cold-patch and joint-filler, but a lack of uniformity in these materials has led to the adoption of standard specifications for both tars and asphalts for 1923.

The foregoing paper was presented at the Ninth Annual Michigan Conference on Highway Engineering at the University of Michigan.

FIVE YEARS EXPERIENCE WITH PATROL MAINTENANCE IN WISCONSIN

By J. T. Donaghey, Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

Conditions existing in Wisconsin prior to April 1, 1918, were similar, I believe, to those existing in a majority of the Middle-Western and Western States at that time. Under the provisions of various laws, individual roads had been constructed and a very small amount of maintenance work had been done, and what had been done was entirely unsystematic. We had built to that date under our state aid and county aid laws approximately 3,375 miles of surfaced roads and 2,800 miles of unsurfaced roads, but no effective provisions were made for their maintenance. In a very few instances proper maintenance had been provided, but in a majority of cases the roads were permitted to deteriorate rapidly.

Prior to the enactment of the law providing for maintenance of the State Trunk Highway System, our department had made quite thorough investigations in our own state and in neighboring states of the most practical and satisfactory method of maintenance of both surfaced and unsurfaced roads, and especially the most practical methods of improving ordinary town roads where nothing more than ordinary township road work had been done. From these investigations and from our years of experience dealing with the local town boards and the county boards of the state, we believed it possible, practical and economical to install a patrol main-

tenance system on a large state trunk highway mileage.

We were satisfied that many miles of the unimproved town roads could be transformed into reasonably good roads, for light traffic at least, at a very small cost, providing ordinary intelligence and proper equipment were used, and that in so doing we would be serving the people of the state of Wisconsin much better than by building each year a few more miles of high type surfacing.

Wisconsin has 78,000 miles of all classes of highways. At the time of taking over the maintenance in the spring of 1918, our records show that 255 miles were concrete; 1,775 miles stone macadam; 15,670 miles gravel, most of which was ordinary town work; and 60,300 miles earth. We believed that a system containing not less than 10 per cent of the total road mileage of the state would be required to serve traffic reasonably well, and that eventually the public would demand that not less than 20 per cent of the total road mileage be adequately maintained. However, we felt that the maintenance of a 20 per cent system was many, many years in the future.

In the construction of a large mileage of different types of road under the state aid and county aid laws before mentioned, the county was the unit doing the work. At the same time the work was performed under the plans, supervision and direction of the Highway Commission. This plan developed a construction organization in every county and also resulted in a large amount of road building equipment being purchased by each county. The counties were expending quite large sums of money for that time, practically all of which was force account work and they were probably getting more for their money than if the work had been done by contract, due in a great measure to the fact that appropriations were not large. Improvements were originated in more than 50 per cent of the instances by township votes. Therefore, the projects in the early days seldom exceeded $3,000 to $5,000 which was expended in a majority of cases on grading and culverting and lower types of surfacing.

Maintenance Plan

In discussing the future maintenance —of a large state trunk highway system before the legislature of 1917, the question arose as to whether the state should maintain the entire system with a state organization, the state paying the entire cost, or whether the actual maintenance work should be done by each county and the county be reimbursed by the state after the work was satisfactorily performed. There were many advocates for each plan. After analyzing the two plans thoroughly, we arrived at the following conclusions.

Under the state maintenance plan it could readily be seen that:

(1) The Highway Department would have closer control of the entire maintenance operations.

(2) The work done might be better and more economically done and in many instances done more promptly.

(3) The costs of the work would be more accurately kept and unit costs of work could be shown on many specific parts of the work which would be of considerable value on other similar work in the state.

On the other hand, it could readily be seen that:

(1) It would require an appropriation sufficient to purchase approximately $2,000,000 worth of necessary maintenance equipment. This appropriation would have been very difficult, if not impossible to obtain from the legislature at that time.

(2) It would require an organization of experienced maintenance men that would be difficult to procure without employing the very men who were employed on road work by the several counties.

(3) It would result, in many instances, in the operation of a state road maintenance crew in close proximity to a county road crew, which would be undesirable, as our laws permit state employes to work but eight hours per day while county forces may work ten hours.

(4) There would be no incentive other than the example of good maintenance shown by state work to induce the local communities to maintain other roads not a part of the State Trunk System.

(5) Criticism of our work as a state organization would come from the other side of the road fence, which in many instances would not be constructive or helpful criticism.

If a plan of operating through the counties were adopted, it would have the following advantages:

(1) The county organizations previously employed in each county to build roads could be utilized to maintain the state trunk system; that is, trained men familiar with conditions in the county

would be put in charge of the maintenance work in each county.

(2) The equipment owned by the counties would go a long way in providing the necessary tools and machinery for the maintenance work, removing the necessity of purchasing duplicate machinery.

(3) The counties, represented by their local officials, would be actually doing the maintenance work, and the general public would criticise them as freely as it would state officials doing such work. The Highway Commission's criticism of the counties' work probably would be much broader and more constructive than the counties' criticism of state work would be.

(4) The fact that the local officials were actually in charge of the maintenance work would inspire them to want a larger mileage maintained locally, and through their efforts sentiment would be developed for the proper maintenance of additional roads in every community.

The possible defects of this plan would be:

(1) The lack of co-operation between the county officials and the State Highway Department.

(2) The possibility of work costing more than in should, due to lack of proper supervision.

(3) The possibility that some of the work would be done in a more or less slip-shod manner.

After weighing both plans thoroughly, the Commission decided to operate through the counties as a unit, primarily because it believed that the sentiment which would be created for the improvement of roads other than those contained in the State Trunk Highway System would eventually more than offset the possible inefficiency and other unsatisfactory features of this plan.

Organizing a Patrol Maintenance System

In April, 1917, a law was enacted creating a State Trunk Highway System to be selected by the Highway Commission and a special committee of five legislators appointed by the Governor. The law provided that on May 1, 1918, the counties must take over the maintenance of the system selected.

For convenience in handling road matters, the Commission has established nine divisions, containing approximately eight counties each. A resident engineer, called Division Engineer, is in charge of each division, having the necessary assistants properly to plan and supervise the work in each division. An assistant, known as Division Maintenance Engineer, has charge of all maintenance, marking and signing. The latter visits each patrolman at least twice a month, reporting each visit by a card to the main office. In 1922, 10,940 visits were reported, giving us accurate information at all times as to the exact condition of each section.

Each county is governed by a county board, consisting of a representative from each township and village and also one from each ward of every city. The county board elects a committee of three to represent it in all matters connected with road work, and also elects a county highway commissioner who has direct charge of all road construction and maintenance work done by the county. Each county highway commissioner has an assistant known as Patrol Maintenance Superintendent who is in charge of maintenance. He visits each patrolman at least twice each week, insuring very close supervision.

The county road committee really acts as a board of directors and as a buffer between the county highway commissioner and the county board on the one hand and the State Highway Department and the county board on the other.

Prior to the selection of the system authorized by the legislature, our division engineers made a condition survey of all competing roads showing the actual conditions existing on every mile. After the selection of the system another survey was made, at which time the distance was measured accurately and stakes set each mile locating future mile posts. The information on each mile shows by tenths of a mile the soil, drainage, type of surface and condition. This information was very helpful later on in planning the patrol system in each county.

The law under which we operate did not provide especially for a system of patrol maintenance. It did, however provide that "each county must adequately maintain the portion of the system lying within the county, according to the specifications, directions and to the satisfaction of the Highway Commission."

The Commission determined, however, that a thorough patrol system must be installed at the very beginning which would cover every mile on the system, whether previously improved or not. The portion of the system lying in each county was divided into patrol sections by the county committee, acting jointly with the county highway commissioner and

our division engineer. The patrolman for each section was selected in the same manner. The county committee advertises in the local press that on a certain day those seeking the jobs of patrolmen for the coming season must report at the county courthouse. The applicants "if new" are interviewed by the county committee and our division engineer and the most promising candidates are given the positions. Applicants having served as patrolmen one or more seasons are given preference over new men and they usually receive more salary.

Each patrolman enters into a written contract with the county and gives a bond in the amount of $500 for the faithful performance of the work and proper care of the tools and machinery entrusted to him. The contract is also subject to the approval of our division engineer.

"On "team patrol sections" the patrolman must furnish a team and wagon satisfactory to the county, the county furnishing a light blade grader, road planer, plow, slip scraper and miscellaneous small tools. On "motor truck or tractor patrol sections" the county furnishes all the equipment.

The salaries paid on team patrol sections range from $140 to $165 per month for the 1922 season; those on motor truck and tractor patrols average about $110 per month. The season extends from about April 1 to December 1, and from December 1 to April 1 the patrolman agrees to work when requested at a fixed price per hour.

The "team patrol sections" average about six and two-thirds miles each, and as a rule are confined to earth road sections and those gravel sections that carry light traffic. We have few tractor patrol sections. They average about twelve miles in length and are generally confined to earth roads but are sometimes preferable on heavy traffic gravel roads where heavy maintenance equipment is necessary. Motor truck patrol sections average about 18 miles, and are economical only on heavy traffic roads where heavy maintenance equipment is necessary and where new material must be hauled regularly, on surface treated stone or gravel, and for work on concrete surfacings. We find that on earth or gravel sections where traffic does not exceed an average of 200 vehicles per day the "team patrol" is cheaper and more satisfactory than any other.

Maintenance Costs (State Trunk Highways)

The 1917 legislature provided for a 5,000 mile State Trunk Highway System, which the legislature of 1919 increased to 7,500 miles.

Table I shows the actual miles maintained by patrol methods each year, the number of patrol sections, the salary paid patrolmen, the patrol maintenance cost of each type per mile, and the amount expended per mile out of maintenance funds for "betterments." "Betterments" consist of widening the road and providing drainage with heavy blade grader work, light resurfacing, new culverts, and the cost of marking and signing the system.

County Trunk Highways

During the first month of patrol maintenance in 1918, the actual driving conditions in Wisconsin were improved far beyond the expectations of the most optimistic friends of patrol maintenance. Again when the entire system was adequately marked during the week of June 22, 1918, making it possible for the dumbest person from Illinois, Iowa, Minnesota or any other state to travel the length of Wisconsin without asking directions, our hopes were fully realized and the public expressed approval of the system in no uncertain terms.

Several county boards met during the

TABLE I—DATA ON PATROL MAINTENANCE IN WISCONSIN

Year	1918	1919	1920	1921	*1922
Actual Miles Maintained	4,998.9	4,998.9	7,234.0	7,260.4	7,458.59
No. Patrol Sections	561	561	791	911	940
Monthly Salary Team Patrol...$	130.00	$ 145.00	$ 165.00	$ 155.00	$ 150.00
Monthly Salary Motor Patrol..	90.00	110.00	125.00	115.00	100.00
†Earth	135.21	154.01	187.24	196.21	186.40
†Gravel	120.80	133.63	184.68	193.85	183.25
†Stone and Gravel Surface Treated	574.21	626.33	706.11	682.23	671.84
†**Concrete	162.21	210.42	220.18	322.21	311.85
Cost Patrol Maintenance	573.042.16	767.302.12	1,220,535.00	1,326.927.24	1,355.900.00
Cost of Betterments.....	396,449.65	488,529.68	756,474.38	1,028,976.04	952,850.00
Cost of Marking & Signing...	7,888.22	17,776.16	28,820.61	20,462.14	41,250.00
Total Expenditures .....$	977,430.93	$1,273,607.86	$2,005,829.89	$2,381,413.85	$2,350,000.00

The above total expenditures average $278.00 per mile per year.

*Final costs will vary somewhat from figures shown, as the season is not complete at this date (Dec. 15, 1922).

**Annual costs include all shoulder maintenance, which runs high on all surfacing less than 18 feet.

TABLE II—COUNTY PATROL MAINTENANCE ON SECONDARY ROADS

Year	1918	1919	1920	1921	1922
Miles Maintained	2,021	5,590	7,743	8,980	9,885
Number of Patrolmen	232	705	970	1,123	1,236
Average Monthly Salary of Patrolmen	$ 125.00	$ 140.00	$ 160.00	$ 150.00	$ 145.00
Cost of Maintenance	475,000.00	1,226,267.00	1,435,527.00	1,867,615.00	2,279,804.00
Cost of Marking and Signing		3,600.00	9,300.00	8,100.00	11,000.00
Total Expenditures	$475,000.00	$1,229,867.00	$1,444,827.00	$1,875,715.00	$2,290,804.00

The above total expenditures average $214.00 per mile per year.

month of June, 1918, and provided for adopting patrol maintenance on important secondary roads. The growth of this sentiment is shown by table II, showing the miles of county trunk highways taken over for maintenance each year by the several county boards, number of patrolmen employed, salary, cost of marking and signing, and total expenditures.

Table II, bears out our original ideas and proves to us, at least, that the plan of operating through the counties has resulted in local demands for more roads to be maintained each year by patrol methods and consequently a much greater mileage of patrolled roads. In addition to the 7,500 mile State Trunk System, we now have a 9,880 mile County Trunk System, making a total of 17,380 miles of well maintained roads. This gives more than 80 per cent of our population direct service, and brings patrolled roads within two miles of the remaining 20 per cent.

Results Obtained.

The "Wisconsin Idea" from the very beginning has been to "serve traffic." The patrol maintenance plan adopted in 1918, improved upon from year to year, and extended to include additional county highways each year, has certainly "served traffic" better, and satisfied the public to a greater degree than the expenditure of the same amount of money each year in constructing a few miles of high type surfacing would have done.

After five years of patrol maintenance we find that the following conditions prevail:

1. Every town, city or village in the state is on a well maintained and marked highway.

2. Traffic is distributed over a large mileage, reducing congestion on many highways.

3. The average speed of traffic has been increased at least ten miles per hour, resulting in time saving beyond computation. W. W. Rowland ("Brownie"), of the Milwaukee Journal, drove the entire length of our longest State Trunk Highway (No. 10) from Superior to Beloit, a distance of 492 miles, between sunrise and sunset, May 25, 1922. Deducting time for stops, he averaged slightly over 40 miles per hour the entire distance. Most of the surface is light gravel, there being but 28 miles of concrete on Trunk Highway 10.

4. Night driving is safe and practical and our traffic census shows a marked increase each year in night traffic. Prior to five years ago, no sane person would think of driving from Milwaukee to our northern lake district during the night (300 miles), while now the practice is becoming very common and popular.

5. Prosperity immediately becomes noticeable. The farmers along such routes soon vie with each other in promoting neatness in their road fences, farm buildings and entrances. Farm names appear over the gateway and the mail boxes are given a fresh coat of paint. Letterheads even show the location of the farm by Truck Highway route and mile number. Products of the farm are sold direct to the city dweller at a price satisfactory to both. In the villages and cities along the route new "Inns" or "Tea Rooms," rest rooms and garages spring up to serve traffic.

6. Last, but not least, is the tourist, and our definition of a "tourist" is any person using our highways for pleasure, whether residents of Wisconsin or not. They tell us that we have the best maintained and marked highway system in the world. We realize that nature has provided Wisconsin with scenic features in abundance; nevertheless, the tourist today would not be with us if our highways did not make traveling by motor car a pleasure. It is extremely difficult to estimate the total amount spent in Wisconsin by tourists. From the most accurate data available we are confident that it now exceeds $100,000,000 annually. The little village of Kilbourn, located at the lower entrance to the "Dells of the Wisconsin," containing a population of but 1,200 people, furnished us accurate records kept by the banks, hotels and business houses for the 1922 season, showing that over one million dollars was left in that vicinity alone by tourists; also that a count taken by the business men's association one night registered more people camped in the Village Camping Grounds

than were living in Kilbourn. Practically every town on a patrolled highway now provides a free camping ground for tourists.

We are satisfied that during the five years of patrol maintenance, 1918-1922, the tourists have left not less than $300,000,000 in Wisconsin. Figuring a net profit of but 20 per cent, which is very conservative, the profits from this source would be $60,000,000, or about seven times the total expended for patrol maintenance and marking and signing the State Trunk System since April 1, 1918.

The Future of Patrol Maintenance.

We are satisfied with the progress made and the results obtained through our patrol maintenance system during the past five years, *but not contented.* Our patrol maintenance has improved each year and *will continue to improve.* The surface has only been scratched insofar as marking and signing is concerned. We will abandon the telephone marker as rapidly as possible, replacing them with standard markers placed along the shoulders of the road. Special signs were erected in 1922 at the entrance to each city or village, giving the name and population. In 1923 we will place signs at all lakes and streams, giving their names. Following this, signs will direct the traveler to all scenic and historic places, both on and off the system, giving direction and distances to them. Certain shaped signs will be erected along the shoulder of the road to denote certain dangerous conditions. One shape will indicate "Stop;" another "Slow;" another "Caution;" and another that the highway which you are traveling turns either right or left. There is really no limit to the service that can be rendered traffic along the line. We naturally feel a certain amount of pride in our marking and signing, and especially in the marking of all detours around construction work and the Highway Service Map published weekly showing roads open for travel and their condition, also the detours and their condition.

We expect local sentiment to continue to develop from year to year. We hope to increase our State Trunk Highway System to 10,000 miles in 1923, which will permit the counties to take over 2,500 miles or more of the most important town roads remaining. We expect that within five years the counties will be maintaining 20,000 miles in addition to the State Trunk System, making in all about 40 per cent of our total road mileage.

The local authorities will never adequately maintain the roads they use daily, and if the town roads are ever to be improved, they must be taken over by a larger unit of government. We are optimistic enough to feel that in the not too distant future the counties will take over all of the important local town roads and apply patrol maintenance, believing this to be the only practical solution of the town road problem.

After five years of patrol maintenance, we are confident that the people of our state are completely sold on the plan and are willing to pay for the pleasure and convenience it has given them.

The time may come when we will favor direct state maintenance. However, the thorough co-operation of the county officials in actual charge of maintenance and the sentiment developed by them locally for additional patrolled roads and road improvement in general, confirms our original opinion that the co-operative plan of maintenance would result in the greatest good to the greatest number in Wisconsin.

The foregoing paper by Mr. Donaghey was presented at the recent annual meeting of the American Road Builders Association.

THE PROVINCE OF THE HIGHWAYS IN THE NATIONAL TRANSPORTATION PLAN

By C. C. Williams, Head of Department of Civil Engineering, University of Illinois, 201 Engineering Hall, Urbana, Ill.

A few years ago, it was my pleasure to go out through St. Paul's Gate at Rome and traverse with frequent stops the Appian Way, and to have the opportunity to observe that admirable highway running off to the southeast from the city, which has been in continuous use for about 2,000 years, although resurfaced of course many times in that period. Jogging along behind a lazy team of skinny horses, my thought was directed first to the remarkably good roads built by the Romans, and second to the plethora of oratory that I have been compelled to listen to at various times and occasions on the theme of Roman roads as an argument for building similar roads in our own day.

This reasoning from ancient Roman civilization to modern American social and economic conditions is much more likely to lead to pedantry than it is to sound policy, hence I shall not do more than to

take the suggestion of a theme from the comparison.

The fact that Rome was a militaristic nation and had highways only for inland transportation compelled the construction of good roads, as the only means of moving armies and supplies. As a matter of fact, her boasted highways were probably about equal to the second class highways of Illinois at the present time, although more substantially constructed. Whether a peace loving America, restored to "splendid isolation," with an extensive network of railroads whose capacity incomparably exceeds the Roman highways and with a possible system of magnificent inland waterways available, should build large capacity highways will certainly have to be decided on the basis of present needs rather than the argument "because the Romans did thus and so."

However, one important fact stands out. The Roman empire was an efficient governmental machine, and so far as the Italian peninsula was concerned, was fairly well knit together. The well designed highways doubtless contributed largely to this result because they constituted a relatively effective transportation system. Highways alone served the purpose of the Romans, for the transportation afforded was in keeping with the entire life and customs of the time, but our civilization is built around a high velocity transportation, and low velocity transportation facilities will not serve the modern purpose adequately.

The agencies entering into our national transportation, so far as carrying of commodities is concerned, are: (a) externally, the merchant marine and (b) internally, the inland waterways, the railways (steam and electric) and the highways. Whatever development may occur in aerial transportation, it will probably have but little bearing on highway and other forms of transportation. The proper development of these agencies of transportation requires coordination into the most efficient relationship rather than an independent program for each.

Inland Waterways

The extent to which inland waterways may be economically developed in America is a much mooted question, and it is not the province of this paper to enter into the discussion. I may say, however, that it is only a question of time, in my opinion, when Chicago and other cities on the Great Lakes will be virtually ocean ports through the completion of the St. Lawrence Water Way and also the cities on the Lower Mississippi will have the advantage of direct oceanic shipping by having lighters ply directly between their wharves and ocean going vessels, much as is done at Paris on the Seine and at ports on the Rhine. The Middle West cannot continue to be strangled by being compelled to force its foreign trade through a bottle neck at New York. I believe, therefore, that a limited system of inland waterways will be an essential part of our ultimate transportation facilities.

Moreover, I believe that in the due course of time, sectional prejudice and jealousies, which so frequently obstruct the view of national policies, will give way to a recognition of the necessity of national marine shipping, and that we shall have an oceanic merchant marine, even though subsidizing may be required for its successful operation. The prosperity of the nation as a whole is dependent to so great an extent upon the adequacy and reliability of our foreign shipping and the prosperity of one section is so inextricably bound up with that of the nation that it is short sightedness for one section of the country to attempt to divorce its economic policies from those of the nation and have no interest in a measure of such importance to the nation as a merchant marine.

Let it be assumed then that these agencies are to constitute our national transportation machinery and that they are to be co-ordinated according to some plan, so that we may proceed under the title of this article. Thought must be given to the relation which these agencies should bear one to the other, and it is the purpose of this discussion briefly to direct attention to that question.

Do the external transportation facilities have a bearing on internal transportation strategy? This factor should certainly be taken into account, for our internal lines of traffic as well as port facilities must be planned with a view to the traffic routes of the world. Does not the fact, for example, that the opening of the Panama Canal has made New Orleans the second port in the U. S. have a significance? It does, for if our traffic is to go in that direction, our internal traffic lines should be arranged to provide for shipping accordingly. Obviously our internal transportation lines must be arranged in a measure with a view to the traffic routes of the world's commerce and cannot be properly fixed with reference to internal needs only. Therefore it may

be taken for granted that our national transportation plan will need to be a comprehensive one and will include marine shipping facilities.

Present Extent of Transportation Facilities

The internal transportation agencies consist of the following:

15,000 miles of inland waterways, in a more or less workable condition, consisting chiefly of rivers. 260,000 miles of steam railways and 40,000 miles of electric interurban railways, 2,500,000 miles of highways, 12 per cent of which or 300,000 miles are improved highways.

These agencies, should be co-ordinated into a plan with two objects in mind, namely: (1) efficiency in economical transportation and (2) factor of safety against failure of the transportation machine. To achieve the former, each agency must normally perform the service for which it is best adapted; to achieve the latter, the highways should be so linked up with both the railways and the waterways that either of the latter may be cut out when incapacitated by strikes, floods, a public enemy, or other cause and still permit the vital activities of the country to proceed, although inefficiently.

Specifically in this scheme, what shall be the function of highway transport?

Obviously all these agencies constitute the commercial circulatory system of the country, the railways and waterways being the arteries and veins and the highways serving primarily as the capillaries. The highways should begin where the trunk line agencies leave off. They should cover the country as an area rather than operating between certain urban centers.

At the same time, in order to provide the necessary transportation when the railways may be out of commission, there will obviously be needed certain trunk line highways between large industrial and commercial centers. These will necessarily be paved with a surface capable of sustaining heavy truck loads. A hard surface double track highway, it may be stated in this connection, increases the transportation capacity (speed x time available x load carried) about ten times as compared with an unimproved earth road. This increase in transporting capacity is comparable with the ratio of increase in capacity if a single track railroad were changed to a six track line.

Traffic Increases

All of these agencies of transportation are needed if we are to have reliable and adequate national transportation. Some years ago, I had occasion to make some studies with reference to the variation of traffic with the increase in population. The data collected show that freight traffic increases with the 3rd to the 7th power and passenger traffic with the cube of the population. In 1910 the population of the United States was about 91 million and at present it is about 110 million. The traffic requirement, therefore, has more than doubled in the past ten years, assuming the traffic to increase with the 4th or 5th power of the population. That this increase in traffic is not being carried by the railroads is evident from a casual study of the increase in their capacity. Since 1910, the railroad mileage has increased 9 per cent, the freight cars 20 per cent, and their actual traffic in ton miles carried, 40 per cent. Obviously a large amount of transportation is being taken care of by agencies other than the railroads, the chief of which is the highways. During the war the railways were found to be inadequate to care for the nation's transportation and almost constantly now they are found to be deficient in certain respects. The railways at present have a total transportation capacity much below the nation's requirements, and if the highway transport were not available, the public would be suffering from clogged commerce even more seriously than is the case now. Therefore we may conclude that we shall need all available agencies of transportation. Indeed, unless the capacity of our national transportation system is increased rapidly in the near future the nation's commerce will be seriously hampered because of the lack of transportation capacity.

With our present highway transport facilities, while no figures are available as to the actual accomplshment of trucks, it is probably safe to say that the freight movement by trucks competitive with railways is small as compared with the 500 billion freight ton miles annually carried by the railways. The present contribution consists of terminal, local urban and rural carriage, and it is in this respect that the highways are contributing so largely to the transportation required by the country.

The Function of Highway Transport

In fact, this, as stated before, is the natural sphere and function of highway transport. While an explicit statement as to the economic length of haul for motor trucks as compared with railways

is impracticable, yet even a casual study of operating costs readily reveals that trucks cannot compete with the railways normally for very long hauls, even for L. C. L. freight, and they are out of the running for most C. L. freight. Roughly 25 cents represents operating costs per ton mile by truck and less than 1 cent covers operating costs of haulage by rail, and it does not require a very long haul to cause the greater haulage cost to more than offset the costs of handling at terminals. The exact distance at which trucks can compete with the railways will be determined by balancing the following items for railroad haulage, namely:

Cost of crating and packing; cartage to freight house from shipper's warehouse; cost of unloading; cost of loading to trucks at destination; cost of cartage from freight house to the consigner's warehouse; losses due to damage and theft, and cost of delay in delivery, against: The greater haulage cost by trucks and the cost of additional insurance required in truck transportation.

Just what the answer is to this equation in any particular instance depends obviously upon labor costs, the distance of local haul to and from freight houses, and the character of the cargo. The value of quick and direct delivery makes it possible to haul fruit and other commodities which either deteriorate rapidly or are subject to a heavy market demand, distances far exceeding the economic haul when this factor is not important. In fact this factor may increase the economic haul from 7 or 10 miles under normal conditions when the value of expeditious delivery is neglected to 150 or 250 miles when the factor is maximum.

Illogical Basis of Freight Rates

In order that there may be a proper adjustment of function between railway and highway transport it is necessary that railway rates be placed on a more logical basis than they are at present. Without reviewing the history of railroad rates at length it may be stated that they are entirely arbitrary and in most cases bear little relation to the cost of rendering the service. The rate structure with all its eccentricities and absurdities was crystallized in 1889 when an interstate commerce law was passed requiring no change in rates be made without approval. Since that time only horizontal increases or decreases, and minor adjustments have occurred. The entire rate structure shrieks loud for fundamental revision and placing on a rational basis of cost of service.

A very large proportion of the cost of railroad transportation consists of station or terminal expenses. Loading and unloading, trucking, weighing, etc., make up a startlingly large cost which must be provided for in freight rates. Moreover, the real estate occupied by downtown freight houses in large cities is so valuable that the fixed charges run unduly high. Mr. E. H. Lee, Chief Engineer of the Outer Belt Railway of Chicago states that the fixed charges are more per ton on freight passing through Chicago freight houses than are the costs of handling the freight through these houses. It has been stated by good authority that the total terminal cost per ton at New York is so great that the rate to all points within 100 miles should be constant, the actual haulage cost being negligible in comparison; and that this terminal charge at New York is as great as the haulage charge to Buffalo. Yet our freight rate structure practically neglects this fact of station and terminal costs, the L. C. L. rate being irrational and inadequate.

Rational Rates

A freight rate to be rational should consist of the following elements: (1) a station or terminal charge plus (2) a haulage charge plus (3) insurance charge plus (4) a commercial differential.

The terminal charge should be determined by the actual cost of handling for the different classes of freight. The handling element of this charge would depend upon the space ocupied. The terminal charge would also depend upon the facilities involved, whether a siding, a crane, an elevator or a freight house with hand trucking. The difference in rate between L. C. L. and C. L. freight is supposed to provide for this factor, but it does not do so adequately.

The haulage charge would depend upon the weight and space occupied by the commodity which would affect the proportion of pay load in the combined weight of car and cargo. Fifty tons of furniture or automobiles that would require four cars obviously should bear a higher haulage rate than 50 tons of coal all in one car. The haulage charge would vary directly with the distance the cargo is hauled.

Insurance against damage and theft is a definite and legitimate charge because the risk is a real and, to a certain extent, an unavoidable one. This factor also enters into all forms of transportation, and should be duly considered in any comparison of agencies of transportation.

The commercial differential would nec-

essarily constitute a part of the rate in recognition of the ability of certain classes of commodities to bear a heavier freight rate than others. Practically this element might properly include the third or insurance item. It would be a percentage of the value of the commodity and would correspond to the profit that any business received for handling a commodity.

Such a three-part scheme of rates at first thought would seem further to complicate the rate structure even beyond the labyrinthian complexities of the present. On the contrary it could greatly simplify the rate structure by unifying and simplifying freight classifications and eliminating special commodity rates.

The gain to be derived from a rational freight rate structure would be the natural selection of facilities and the operation of the various agencies of transportation in the spheres to which they are best adapted.

Notwithstanding the higher rates for short haul L. C. L. freight it is the business on which the railways at present make the least profit owing to the expensive station handling. If rates were made in proportion to actual cost of rendering the service, this business would naturally fall to trucks which are in a position to eliminate the waste of labor at the station or terminals.

The logical function of highway freight transport, therefore, consists of local distribution from and to the railroad and short hauls of L. C. L. freight between towns. In addition to this a certain amount of truck line transportation should be made possible over the highways to provide for the emergencies when the railways may be thrown out of commission by strikes, by floods, or any other contingency.

The Supplementary Function of Highways

It is economically impossible to construct all highways to carry even moderately heavy loads, and economically impossible to construct even trunk lines to carry the loads which some would desire to place upon them. In other words, the highways cannot economically be designed to carry loads which might make possible their competition with the railways for heavy and long distance transportation. Moreover, with the highways designed as they must be for light moderate damage to the highways than a thousand light to moderate loads. Obviously it is not fair to allow 5 per cent of the traffic to do 95 per cent of the damage to the roads, for the cost of construction and maintenance is distributed in no such ratio. If license fees are properly adjusted, unduly heavy loads will be kept off pavements not designed for them, and with such fees supplemented with rigorously administered fines for violating the legal limitations the entire control of the situation may be secured.

This aspect of the question might be enlarged upon further but enough perhaps has been said to indicate the conclusion—a conclusion indeed which is not new but which has been pointed out by several others—namely that the function of highways transport is to supplement the railways and the waterways rather than to enter into competition with them. This is an economic conception and like most economic principles, physical or engineering instrumentalities are necessary to make them effective.

Highways may supplement railways first by securing more adequate local transportation in the areas which have heretofore been served by the railways, namely, the region extending 5 to 10 miles on either side of the railway, and second, they may bring transportation service to the more remote areas which have been very inadequately served.

The Container Car

The container car, which has recently come into use and which has been described at various times in the engineering periodicals, bids fair to furnish the liaison instrumentality for making this supplementary co-operation real to a great extent. In this scheme the bodies of the trucks are lifted by crane directly from the truck to the car, about eight or nine truck bodies constituting the body of the car. Much of the expense in handling is thus eliminated. The chief difficulty is the lack of corresponding facilities at small way stations. However, this or some similar device will probably be used extensively in the future to effect this co-operation which most students of the question agree is desirable. Mr. W. H. Lyford at a recent highway conference at Washington, made the statement that "In Chicago, the interest charge alone on real estate at 12th street on which a freight station is located is $2.30 per ton of freight handled through the station. If the station were located at 33rd Street, such interest charge would be about 80 cts per ton. The amount of interest saved by moving the station to 33rd street would pay the cost of well organized cartage between 33rd street and the premises

of the trader." A few years ago, while working on the design of a freight house for the C. M. & St. P. Ry., I had opportunity to make a study of the actual conditions of congestion at the downtown freight houses in Chicago and I may safely say that the delay in loading and unloading at the platforms costs the Chicago shippers many thousand dollars daily. Here, then, is a proper field of co-operation in large cities.

The collection and delivery of freight by the railroads with their own drays or trucks, as is done in England, is probably not feasible under our present scheme of organization, because it would be wasteful of effort for every railway to maintain its own truck or cartage organization even in a large city. The solution to this situation may lie in a further extension of terminal railways, which will handle all transportation, both on rail and on street, within the city, and turn the cargoes over to the various lines to transport to destination, to be turned over there in turn to a corresponding terminal transportation concern for delivery. In fact the terminal railway is so demonstrating its entire justification in large cities from various considerations that it promises to be adopted in all large cities. If terminal railways miss the opportunity of performing this store door delivery service, the alternative seems to be terminal trucking organizations, which in my judgment would be a less satisfactory scheme.

The second aspect of the supplemental co-operation between railways and highways is an important one and one whose influence will extend in the future; that is, the more completely bringing transportation service to districts remote from railways.

Until the railways were built the United States consisted of a line of commercial states along the Atlantic seaboard, a wilderness nominally organized into states west of the Alleghenies, whose settlements were limited to towns along the rivers. The advent of the railways wrought a mighty change. Inland cities sprang up and the railroads deliberately developed industrial centers with a view to their future traffic business. This scheme of economic development was satisfactory until the large industrial and commercial centers grew so large and required transportation service beyond the capacity of the railroads. The urban centers of commerce and industry that owe their location and size largely to railroad strategy, are now threatened with strangulation due to the lack of transportation capacity on the part of the railways. Will the advent of highway transport effect a new distribution of commerce and industry in turn a further scattering, corresponding to that change which the railways wrought over the distribution based solely on waterway transport? Only the future can show just what the answer will be, but it seems safe to predict that extensive fundamental changes will result in this connection. Our present commercial and industrial distribution and entire economic fabric are a product or function of the railways; the future will be a function of a more comprehensive transportation system, which by virtue of the highways will be more elastic and more nearly cover the country as an area than does a network of railway lines.

Multiple Axle Trucks

Recent developments in multiple axle trucks give promise of removing the heavy concentrations from the pavement and thus permit heavy loads to be safely carried over the pavement. The 6-wheel truck is becoming fairly common in this country and a 10-wheel truck was recently tried out in London. In this respect, the development by extending the length along the track is entirely analogous to the development of the steam locomotive from one pair of drivers to 8 or 10 pairs.

Passenger transport in cities by motor vehicles perhaps should be mentioned in this connection. Here again proper coordination and co-operation instead of competition will yield the best service as well as the largest net returns to all concerned. Many cities where no electric railways have been established are using motor busses as local transportation with satisfaction. Several large cities, notably Providence, Newark, N. J., Baltimore, Washington, Rockford, Ill., and Tulsa, Oklahoma, have established a co-operation between bus lines and electric railways for covering outlying districts. The fact that practically all electric street railways in the country are in financial difficulties, varying from non-payment of dividends to receivership, leads one to question whether the surface street car line for local transportation of short haul in large cities is not an obsolescent instrumentality. Observation in London and Paris as well as in New York seems to indicate the street railway's proper function to be cross-town transportation. If street car lines are to be limited practically to cross-town transportation and local transportation in heavy traffic areas,

auto-bus transport may be counted on to provide for local traffic under ordinary conditions and to afford transportation for outlying districts. Superior service in transportation also can be furnished for high class residence districts where street car lines are not satisfactory for one reason or another.

Summarizing, I would say that the agencies of transportation should be coordinated into a unified and comprehensive plan, as a basis of which two principles seem apparent: (1) the highways should supplement rather than compete with the railways and waterways and by logical adjustment of transportation rates and of taxes, each agency should be brought to operate in the sphere to which it is best adapted and (2) the highways should be so linked up with industrial and commercial centers and marine ports that either the railways or the waterways might be out of commission by strikes or other cause and yet the vital activities of the country proceed, even though inefficiently. How this supervision of transportation planning is to be accomplished is another question. Transportation as a factor in national life is on a parity with Commerce, Agriculture or Labor and these phases of our economic life are represented by departments in the President's Cabinet. Other countries have placed ministries of transport even ahead of some of these. Possibly a feasible solution is to place the Bureau of Public Roads, the Interstate Commerce Commission, the U. S. National Waterways Commission, the U. S. Shipping Board and other related bodies into one Department headed by a secretary of transportation in the Cabinet. Whatever device may be the best for effecting the desired arrangement, it is eminently desirable that there be a plan which will be comprehensive and unified, and adequate to provide for the transportation requirements of the nation with the maximum degree of reliability, efficiency and economy.

The foregoing paper by Prof. Williams was read at the Short Course in Highway Engineering, University of Illinois, Feb. 19, 1923.

MAINTAINING EARTH ROADS IN IOWA WITH BLADE GRADER AND DRAG

By W. H. Root, Maintenance Engineer, Iowa State Highway Commission, Ames, Iowa.

On Jan. 1, 1923, the primary roads of Iowa were classified as follows:

Paving	334.4 miles
Gravel	1558.0 miles
Graded and drained	1761.1 miles
Not built	2961.8 miles
Total	6615.3 miles

In other words, out of 6,615 miles of primary road, 4,723 miles or 71 per cent of the whole system are unsurfaced. The Iowa Highway Commission has chosen to look upon its primary road system as the backbone of a state-wide transportation system. They believe that the public is entitled to a usable system of roads whether such roads have been constructed or not. As a result of this policy the maintenance forces of the state are required to maintain the whole 6,615 miles of road, 45 per cent of which has not even been built to an established grade line, and of which 71 per cent is ordinary earth road. These figures show, I believe, that the Iowa maintenance problem is an earth road problem and they explain why we have concentrated on earth road maintenance.

The Heavy Blade Grader

I think that I can state without the least reservation that the most useful and indispensable tool for the care of earth roads is the heavy blade grader. By this I mean a grader with a blade length of from 12 to 16 ft., built heavy enough to do work that will require 30 to 50 drawbar horsepower. A blade grader of this sort is adapted to various kinds of work. The three main classes of blade work are:

1. Heavy blade work on roads which have never been built, that is, widening out and building to standard cross-section trails which have never really merited the name "road."
2. Finishing work on new construction.
3. Surface smoothing operations supplementary to regular patrol work.

I will try to show how this work is carried on in Iowa. It was in 1913, I believe, that the first 12 ft. blade machine was shipped into the state of Iowa. Now there are at least 400 of these machines in the state. In our early blade grader work we erred in not doing a thorough enough job. We paid little attention to getting the fences back to the line and clearing the right of ways. We merely shaped up the road as we found it. From 5 to 10 round trips were made and the total cost per mile was only $50 to $75. Each year, however, we have attempted to do more work and get a better road. We now require the fences and

telephone poles to be moved back to the highway line before we start work. All trees, stumps and boulders are then cleared from the right of way. This work alone in some parts of the state, runs as high as $200 or $300 per mile. All heavy weed growths are also cut and raked up and burned. After the right of way has thus been cleared we are ready to start the blade work proper. The ditch line is staked out (18 ft. each side of the center line) with lath. Enough lath are used so that two laths are always visible to the grader operator.

Each mile of road is a problem in itself. An ingenious grader operator will save lots of time and money by cutting down the number of round trips necessary. High side banks, narrow fills off center, and wet ditches are only a few of the things that make a first-class blade grader job difficult and expensive. We much prefer a blade grader with a back sloper attachement, that is, an attachment which may be bolted on the end of the blade so that the ditch bottom and back slope may be cut at the same time as the inside slope. A properly designed back sloper will cut the standard ditch and back slope when the main blade is cutting the standard inside slope. The back sloper should be adjustable so that the back slope can be flattened from 1½ to 1, to 2 or 2½ to 1 where extra dirt is needed.

On an average road we now make from 10 to 15 round trips with a single grader. Some counties still pull two 12 ft. graders with one tractor but I do not believe that this is economical. Where this practice prevails one grader of necessity must lie idle much of the time and the turning is more difficult. The average cost of our blade work including clearing, is about $150 per mile. However, we often have miles which run as high as $500 or $600 per mile. It is surprising the extensive work which is accomplished by some counties with the 12 ft. blade. We have built side hill roads in hilly counties where the material was mostly loose rock, and have had excellent results. Work of this sort when finished looks much more like permanent grading than it does like blade grader work.

No two miles of road require the same treatment, and the cost of blading, therefore, varies greatly. The following figures, however, roughly represent the cost of the average mile:

One engineer, 25 hours, at 75c	$ 18.75
One grader operator, 25 hours, at 60c.	15.00
125 gals. of gas, at 22c	27.50
Oil and grease	3.00
Depreciation on a $6,000 investment, figuring a three-year life of 100 working days per year, 2½ days at $20 per day	50.00
Estimated repair, 2½ days, at $5	12.50
Interest on investment (5% on $3,000), 2½ days, at $1.50	3.75
Clearing right-of-way and incidentals.	19.50
Total	$150.00

The second class of a blade grader work as outlined above, is the finishing of permanent grading. By permanent grading, I mean building a road to an established grade line which is presumably a permanent one. In grading operations in Iowa most of the dirt is moved with elevating graders and dump wagons. We insist on a Mormon scraper being kept constantly at work on the dump but the best job that can be done in this way is necessarily rough. Therefore, we require every grading contractor to have a 12 ft. blade grader in his equipment. This grader is pulled by a large engine and the road finished smooth close behind the rough grading. Often the same tractor that pulls the elevator, is used evenings and at odd times to smooth up the work.

We also find that all new grading settles unequally after a few rains. The shoulders usually become low and ragged, the ditches start to fill, and the back slopes sluff. It then becomes necessary to again blade the job. This last blading is done by the county as a maintenance measure. The back sloper is used. It fits into the ditch and back slope and builds the shoulder up in a uniform manner. The result is a workmanlike job, without perceptible waves and the cost is only $50 or $75 per mile.

The slogan of the National Paint Manufacturing Association "Save The Surface And You Save All" might be studied to advantage by State Maintenance Departments. The public judges a road by its surface. A road is good or bad, as it is smooth and comfortable to ride over at 35 miles an hour, or as it is rough and inconvenient to travel at that speed. The user of the road cares little for clean ditches and nicely lined shoulders, if the surface is rough. This suggests the third and most appreciated class of heavy blade work. We have the patrol system of maintenance in our state but on practically all earth roads on the primary system, we find supplementary maintenance with a heavy machine very necessary. For this work we again prefer the heavy 12 ft. blade grader. In a number of cases we have lengthened these blades to 16 or 18 ft in order to cover the road surface in one round trip. Often we are able to pick up old graders which have become

worn and loose jointed. These old machines can be bought for a song. We equip them with extension blades, put on heavy springs between the frame and the blade, to take up the play, and thus obtain an ideal maintenance machine.

The most difficult maintenance problem that we have is presented by a heavy soil road with heavy traffic, say a dense yellow clay road carrying 1,000 vehicles a day in all kinds of weather. It is obvious that before such a road has a chance to dry out so that it can be dragged, it has been hammered down until it is about as hard as a concrete pavement. However, the riding qualities are not at all similar to those of a concrete pavement. It is rough and rutted and anything but a pleasure to travel over. It is also absolutely beyond the control of any light equipped patrolman. Nothing but a heavy blade will ever put such a road back in satisfactory shape for travel.

Road Drags

This I believe, covers the field of the heavy blade grader. The road drag is also a widely used tool in our state but its work is not so readily classified. We have almost as many different kinds of drags and maintainers as we have operators. We have everything from 2 bladed drags weighing around 200 lbs. and easily pulled by 2 horses to big heavy maintainers weighing 1 ton or more and pulled by 20 or 25 horsepower tractors. I do not expect to enter into a discussion concerning the relative value of these different machines, suffice to say that they most all have their good points. In my opinion the man not the machine, is the important factor. I would rather have a live ingenious man with good road sense equipped with an old fashioned split log King drag than a "dumb-bell" with the fanciest maintainer manufactured.

We divide our earth into patrol sections of about 10 miles each. A patrolman is placed in complete charge of each section and he is held responsible for its care. He is usually equipped with a patrol grader, a drag, a slip scraper, a plow, and a set of small tools. He also has access to other equipment such as wheel scrapers, mowers, etc. He furnishes one team all of the time and in most cases has a second team which can be procured when needed. On the heavy soils we have to use four horses even on a small patrol grader. The patrolman's first duty is to keep the surface of the road smooth. To do this he must drag or see that the dragging is done, on his entire section as soon as possible after each rain. On light soils the dragging can be started after a few hours of sunshine following a rain and the equipment may be either a light patrol grader or a drag. A patrolman on this class of soil can care for his section with not to exceed one extra dragger. On heavy soils it takes much longer for the road to dry out sufficent to drag. Here the first dragging may be done by the patrolman but he will need 3 or 4 extra draggers. Often on this class of road the first dragging is done with heavy equipment.

In no case is one dragging enough. Lighter soils must be bladed with the patrol graders a second or third time until the surface is smooth. The first dragging on the heavy soils only partially breaks up the clods and incompletely fills the ruts. It must be immediately followed by a second or a third smoothing with heavy equipment. As stated before, we prefer a 12 or 16 ft. heavy blade for this final polish.

Summary of Policy

The Iowa earth road maintenance policy and activities might be briefly summarized as follows:

1. Realizing that we will have to depend upon earth roads on a large part of our primary system for a number of years to come, we believe that we are justified in an intensive maintenance program on these roads, in order to give the traveling public service while they wait for our construction program to eliminate the mud.

2. As a first step in this program we have graded with the heavy blade grader, practically every mile of primary road that has not been otherwise constructed.

3. For finishing grading which has been built with an elevating grader and dump wagon, the 12 ft. grader is a most useful tool.

4. The heavy blade is indispensable for surface smoothing especially on heavy soils.

5. Earth roads should be patroled and the patrol sections should not be over 10 miles in length.

6. All patrol and light drag work must be supplemented with heavy maintenance machines.

Our maintenance ideal is continuous, automatic care and definite, individual responsibility.

The foregoing paper by Mr. Root was presented at the recent annual meeting of the American Road Builders Association.

Construction News and Equipment

A DISCUSSION OF PRESENT PRACTICE IN CONSTRUCTING CEMENT CONCRETE PAVEMENTS

By E. G. Willemin, District Engineer, Michigan State Highway Department, Lansing, Mich.

In the consideration of present methods of constructing cement concrete pavements, it will be assumed that the foundation, subgrade or earthgrade and the drainage features of the road have received the painstaking care that is now considered absolutely necessary in good practice. For convenience the subject will be handled in the sequence of operation; that is, the methods employed in (1) the preparation of the flat subgrade or earthgrade for the slab (2) the movement and manipulation of material (3) the finishing of the concrete surface. The subject of construction details will also be considered as to their effect upon the builders' and users' viewpoint.

Preparation of Subgrade

In the preparation of the flat subgrade for the slab it is the practice in Michigan to channel out sufficient earth from the full width of the slab to such depth as to give the proper cross section and volume of earth to complete the shoulders at the edge of the slab. On fresh subgrade or upon loose soils a grader serves well to remove the excess earth outside the shoulder line for future use. On subgrades, well packed by traffic or in stiff soils, it becomes necessary to use heavier equipment in such tools as the plow, scarifier and grader. There has been and still is considerable discussion as to the merits of channeling for the slab. From the engineering standpoint in controlling volumes of earthwork it is necessary to use the surface of the flat subgrade or earthgrade as the plane which eliminates the item of excavation from further consideration. On the other hand, it means that the earth channeled from fills is handled twice. This fault is partly remedied by building our earthgrades 6 ins. wider on each side than the finished width, with the idea of using the wedge of earth of the inner ditch slope as a source of filling material for shoulders. In flat sandy country, channeling may be almost dispensed with, while in rolling country it becomes more difficult for the engineer to balance the deficiency that may exist in cuts and fills to avoid endwise haul. In practice it has been found advantageous to have the engineer actually channel out a strip several feet wide to the cross section, as shown on the plans to demonstrate that in that class of soil sufficient depth has been reached, with or without the wedge of earth on the shoulder, to fill out the shoulders adequately on the edge of the slab to its proper slope and section. The present tendency is to eliminate side ditches as much as possible, but still provide adequate drainage and yet leave no ghastly borrow pits on the back slopes. These restrictions imposed upon the engineer make close control of earth work necessary at all times.

Handling Material

The vital importance of the supply and transportation of material has already been touched upon. The supply should always be at least equal to, but never less than consumption requirements to insure continuous production with a well balanced plant. The facilities of unloading materials from a source involving railroad haul and for its proper storage is therefore given careful consideration. A layout that gives a minimum handling usually guarantees a decreased cost. Each time material is picked up to move, costs rise also, due not only to the cost of movement, but waste of material as well. Yard layouts are now designed to elevate raw material but once, if possible, and to take advantage of gravity movements thereafter. The clamshell, or adaptations of it, equipped with a ¾ to 1 yd. bucket is in geenral use and proves economical. A mobile machine of the caterpillar type gives general satisfaction, as it reduces switching charges, and needs no supporting track to run upon. From this point on the methods of handling materials will be determined by the location of the mixer in respect to the road, so storage and loading methods will be discussed under the different plant types.

Location of Mixer

Transferring our attention now from the unloading plant to the mixer, we find that in general two classifications may be made as to the location of the mixer, viz.: (1) the mixing operating on earthgrade fed by transportation units, (2) the mixer operating off the grade and delivering a wet batch to the transportation units. Under the first classification we may subdivide into three types, the wheelbarrow or stocking of subgrade system, the central proportioning plant or a type, not used to any considerable extent, which consists of a mixer over which storage bins are erected, the bins being filled by a hoisting arrangement and the whole cumbersome affair mounted on rails. Due to the fact that the transportation element must also be considered with each type of mixer layout, I will continue the enumeration of types of mixer layouts not operating on the subgrade, then return to a closer study of each type of layout in its relation to transportation, as well as its peculiar advantages over other types.

Under the classification in which the mixer does not operate on the grade we have two types. (1) A central mixing plant, with mixer fixed and set up adjacent to main source of material supply. (2) A modified central mixing plant where the mixer requires one or more set-ups usually adjacent to the road, its location determined by stock pile or source of supply. It will be noted that the essential difference in types as far as transportation is concerned is the hauling of a dry or a wet batch. There are other considerations previously mentioned, however, that largely determine the location of the mixer in respect to the road and the methods of transportation. I will repeat them as, soil of subgrade, gradients, width of subgrade, water supply, condition of adjacent roads, length of the project, supply of common and skilled labor, length of live and dead haul, availability of local material, time limit of the contract and capital investment.

Wheelbarrow Method

With the mixer operating on the subgrade, let us first consider the wheelbarrow method. This method is still in use, but usually in localities where unskilled labor is plentiful and cheap. Aggregates are usually stocked upon the subgrade. In such a case it is necessary to space the loads of each type of aggregate with care to save long distance wheeling. This requirement would mean a very trustworthy foreman in charge of unloading. Again with materials stocked on the subgrade any corrections that must be made to the subgrade after the aggregates are placed, are very costly. For this reason unusual care must be taken to correct all ruts and uneveness of the subgrade prior to stocking. There is considerable loss of material, as aggregates cannot be picked up clean and economically without combining parts of the subgrade with it. This waste material may run as high as 10 per cent. The human element enters into this method too largely; there is congestion, questionable morale and heavy labor turnover. There is no advantage in stocking subgrade in anticipation of scarcity of material that cannot now be offset by dry batch delivery from the stock pile. A late development is the use of belt conveyor as a substitute for the wheelbarrow. This contrivance eliminates the common labor element, but does not reduec waste of material. When aggregates are not stocked on the subgrade delivery of materials to the mixer may be made by industrial railroad, light or heavy truck. The reliability of mixer supply, however, is questionable in this method. Moreover, it has been demonstrated that the batch system handles the transfer to the mixer more economically. Unless material can be stocked at railroad siding, there is a possibility of the accumulation of demurrage charges.

Central Proportioning Plant

As the name infers, the central proportioning plant proportions the aggregates in a dry batch to correspond to the capacity of the mixer. The plant may be composed of fixed or movable loading bins that serve for storage of aggregate or a tunnel arrangement designed to accommodate an industrial train. Batches may be proportioned by hoppers on the discharge chute of the loading bin or tunnel or by volumetric measurements in compartments of a batch box or of partitional truck bodies. Batch boxes may be of the tilting, side discharge or drop bottom type. If cement is included in the batch, separate compartments for it are preferable. Covers are now provided for cement compartments as a safeguard against wind and rain. The ideal layout for loading is to elevate material but once, so that handling of materials to the transportation units is by gravity. In some large layouts using truck haul, separate loading bins for each aggregate are used. This arrangement requires two stops. In smaller

layouts, where truck haul is used, it is possible to have sand and gravel compartments for each loading bin, thus eliminating one extra stop of the truck per trip. There are likewise opportunities to design tunnels so as to economize on train loading time and dead storage of material.

Hauling Materials

In the consideration of the effectiveness of the central proportioning plant we are at once confronted with our transportation problem. In general the light or heavy truck or a combination of both, or the industrial train alone or in truck combinations, is employed. Tractor train haul has not proven adaptable as an economical method. A fleet of light trucks alone, equipped with pneumatic tires, capable of handling one 4-bag batch, have proven successful under certain hauling conditions. It is argued that the cost of delivery of material in this manner is no more than with a wheelbarrow layout, and that the cost of reshaping the subgrade that is necessary with certain soil conditions when heavy trucks are used is avoided. On a long haul by truck delivery it is also argued that a saving can be effected in handling of material by delivery in heavy trucks to a stock pile, provided the heavy trucks can dump directly into the hopper of a loading bin to be later discharged into hoppers for loading light delivery trucks. The cement may or may not be added to the batch at the central proportioning plant, depending upon the source of cement supply. It may prove feasible to stock the cement in a movable storage house on the road. The methods mentioned contemplate the material brought by truck or train to the mixer, with the mixer gradually progressing forward. A recent plant layout using dry batch heavy truck delivery was so arranged as temporarily to fix the location of the mixer every 1,500 ft. on the subgrade, with the mixer discharging concrete into light trucks for placement on the subgrade. It is needless to say that a turntable would be one necessary piece of equipment in such a layout.

Among road builders the problem of the transportation unit to be used for a given project creates considerable discussion. One builder's experience may have involved the light truck, another the use of heavy truck, while still another the industrial railroad. Contracts have been completed by the use of each type or of light and heavy truck combinations equally successful from the standpoint of the contractor. It is my opinion that the temperament of the contractor and his organization enters into the choice; in other words, a personal equation may be involved. Some builders are willing to take more grief from their equipment than others, as manifested by the maintenance they give the equipment.

Equipment Charges

Besides this consideration there are the more important ones of plant investment, fixed and operating charges. It has been found that certain economic principles apply as well to road equipment as to other types of machinery. Let us consider a few of these principles. It cannot be disputed that where interest charge on the investment plus depreciation is exceeded by the loss due to costly delays in the use of old equipment that new or better equipment should have been purchased. The economy of new or well maintained equipment is apparent where repairs or replacements are difficult to obtain. A piece of equipment is not justified in a well balanced plant unless it co-ordinates closely in output with other units of the plant in giving continuous production. This does not mean, for instance, that the capacity of the clam at the unloading plant per ten hours must be equal to the total aggregates handled in ten hours by the mixer. Its capacity may be less; it may work overtime to maintain the balance of supply with demand, but its capacity should be such that demurrage does not pile up unnecessarily due to erratic shipments, or delays caused to other plant units. Equipment standardized such as mixers now are, should not be overloaded. The machine may stand the strain for a time, but maintenance and depreciation charges will soon discount the apparent advantage. Workmanship suffers also.

Small and Large Jobs

After a road builder has bought his plant and completed a successful season's work, he has no assurance that his plant will balance with the requirements of the next job. There is an opportunity at times for the state and counties to adapt projects to plants. It has not always been possible to do this, however, because of considerations such as taking care of traffic during construction. It is sometimes advantageous to advertise a short job. A small job with a small organization and small overhead can compete favorably in unit price with a large job with

large organization and high overhead. The risk of delay is more costly in a large plant layout. The small plant layout has proven adaptable to a larger variety of jobs. It is true that the large plant may not have yet had the chance to demonstrate its worth due to the uncertainty of material supply. To date it is my opinion that the average net return on the money invested for the large plant has been lower for a season's run than with the small plant. The efficiency of the construction organization is responsible to a great degree for its success or failure. With improper equipment an efficient organization soon loses its efficiency and its interest in the welfare of the work.

Transportation Units—Light and Heavy Trucks

To return to the question of transportation units: With light truck haul, a light truck being considered 2-ton capacity or less, the truck makes up in speed what it lacks in capacity. Its use is favorable with comparatively short hauls, it is easier on the subgrade, parts are more readily replaced in case of breakdown, the time lapse is shorter after a rain for trucks to start running upon roads, and the interest charge on the capital invested is less. An apparent advantage is the fact that truck drivers may be obtained at cheaper rates than for heavy trucks, also mechanics, but how true ultimate costs will be cut is problematical. The investment of the owner in spare parts, however, is appreciably cut. With heavy trucks, on the other hand, a long haul is more advantageous. Due to the fact that for a given volume of haul a less number of heavy trucks are needed, they require less field supervision; there are fewer units on the road to pass each other, less time to load than in four or more light trucks, they are on the subgrade a shorter time in unloading the same volume, thus disturbing subgrader work less. The drivers take more personal pride in the performance of their heavy truck. In fixed charges the storage charge per heavy truck is less than for its capacity equivalent in light trucks. License fees are accordingly reduced. while risks on insurance, liability, fire and theft are less. The charge off for the life of heavy trucks can be taken as twice that of light trucks. Again in subletting truck hauls, it usually proves more satisfactory to sublet to heavy truck haulage concerns, as they are more substantial and trustworthy in general. There are evils in subletting truck hauls, however, due to the fact that the contractor loses his absolute control over his transportation units and condition of his subgrade. Trucks equipped with adequate tires for the capacity of the truck are essential as a remedy for subgrade troubles.

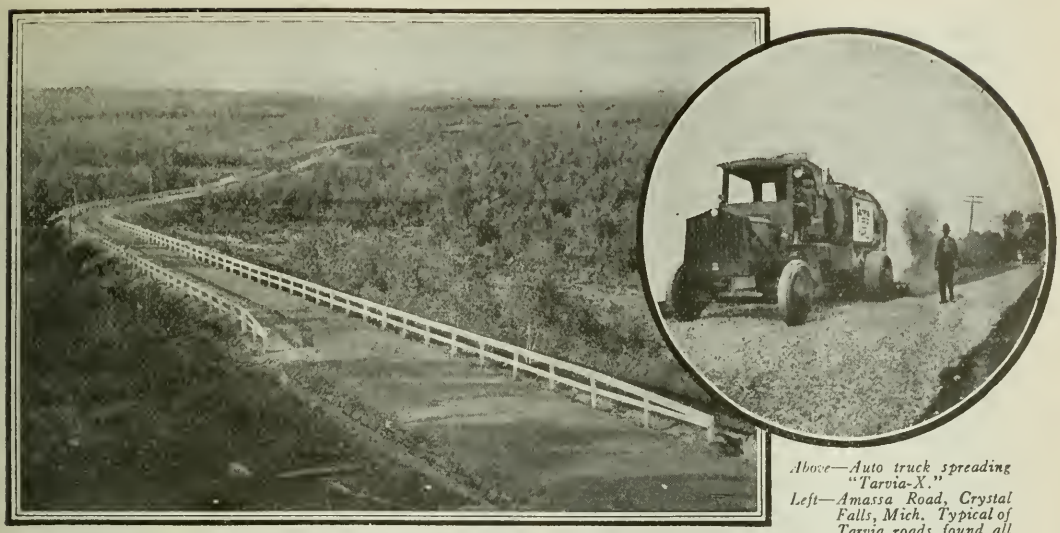
Industrial Railway Equipment

The heavy investment necessary for industrial railway equipment is warranted only on longer projects. Their layout and operation require close study in regard to soil conditions, weight of track, grades, booster engines, temporary and permanent passing switches, loading facilities and tracks using gravity wherever possible in favor of the load. Undoubtedly railroad economies can be profitably applied on some phases of its operation. It has been found that heavier loads should be drawn with the same power unit, or it is more economical to boost on heavy grade than it is to cut the load. Within the last two or three years the power unit has increased in weight and consequently increased the tractive effort with the necessary power. The 7½-ton gas locomotive and the 8x10-ton steam locomotive are preferred. The industrial haul is more reliable in general as a transportation unit than the truck method. The reliability of the industrial haul should lead to continuity of production. Against this advantage we must charge added interest and depreciation of plant investment.

In the comparison of the effectiveness and economy of any transportation unit, the cost per ton mile haul seems the logical basis for comparison. On a given project with a given output of the finished product the volume of material required in tons is constant. The mileage and time involved in hauling are the variable factors of the ton mile basis. We may decrease the tonnage per transportation unit and increase the speed of each unit, or vice versa, and obtain the same output within reasonable limits. The analysis of these factors for each project gives the builder the clew that he seeks as to the type to employ.

Central Mixing Plant

As previously stated in the plant layout, where the mixer does not operate on the subgrade, we are concerned with the so-called central mixing plant or a modification of it. In one case the mixer is fixed quite permanently; in the latter case the mixer can be shifted from stock pile to stock pile. The former must have materials brought to it; in the latter the



Above—Auto truck spreading "Tarvia-X."
Left—Amassa Road, Crystal Falls, Mich. Typical of Tarvia roads found all over the country.

The Country Wants Good Road *Mileage*—

"GOOD ROADS at *any cost*" is a mistaken policy. Good roads cease to be a benefit when the expense of building and maintaining them becomes burdensome. Costly construction slows up automatically the proper development of any good roads program.

What the country wants and needs is greater *mileage* of moderate-priced, low-maintenance all-year highways. Hundreds of towns and counties have found that Tarvia roads squarely meet this demand; that they are the economical solution of the good roads problem—satisfactory alike to road officials and taxpayers.

For Tarvia roads are not only firm, smooth, dustless and mudless all the year round—they are far less costly to build than any other type of modern highway, and far less costly to maintain. Because of these economies, the use of Tarvia insures the most miles of good roads that can possibly be built and maintained with the road funds available.

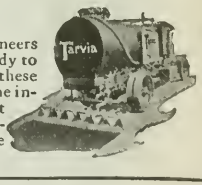
The granular surface of a properly constructed and properly maintained Tarvia road prevents skidding.

"Tarvia-X" is a dense coal-tar preparation which has been proved by experience to be the most durable bituminous binder for road construction. Other grades of Tarvia are made for preserving and patching all kinds of hard surface roads.

Tarvia
For Road Construction Repair and Maintenance

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write our nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.



New York Detroit Bangor | Chicago New Orleans Youngstown | Philadelphia Birmingham Toledo | Boston Kansas City Columbus | The Barrett Company | St. Louis Minneapolis Richmond | Cleveland Dallas Baltimore | Cincinnati Salt Lake City Omaha | Pittsburgh Atlanta Houston Denver

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plant is more flexible in that respect. The operation of the central mixing plant is particularly affected by its design. The bins should deliver a uniformly graded type of each aggregate. The proportioning of the batch should be done just prior to discharge into the mixer. The central mixing plant layout centralizes activities. It would therefore cut supervision costs. This is not so true, however, of the modified type. The modified type might be used economically where heavy truck hauls are necessary to various stock piles along the road, with the soil conditions of the subgrade such that only light trucks could be used for hauling wet batch.

Many different types of portable elevators are now on the market for handling aggregates from stock pile to truck or industrial railroad that could be adapted to the modified central mixing plant.

Many specifications do not allow, others restrict the use of, concrete mixed by the central mixing plant method. Those that oppose its use contend that segregation of aggregates occurs in the concrete in its transportation, especially where long hauls are involved over rough roads. Truck haul is advisable, as by it individual batches are delivered to the project in the least time. Tests were made a year or more ago to determine the probable safe maximum haul of concrete mixed in a central mixing plant. The results as given in Public Roads, the former official publication of the United States Bureau of Public Roads, show in a general way the relative strength and consistency of gravel concrete when hauled in a wet batch and tested at various periods of time up to three hours after initial mixing. The concrete was mixed to a consistency to conform to a 2-in. slump with standard apparatus. Cylinder specimens were made for testing according to standard field practice. It is stated that the experiment indicates that the most practical way to utilize the central mixing plant in concrete road construction is in connection with a machine finisher. It also indicates that so long as the concrete is workable, after a period of hauling, the strength will not be affected. Further experimental work was to be conducted on the effectiveness of this method.

The Inundation Method

One of the more recent developments in the mixing of aggregates for concrete is the so-called "Inundation Method." It consists of measuring the sandaggregate in a container which has previously been partly filled with water in such quantity that when the container is level full the sand is completely soaked. The effect of moisture on sand is variable, depending upon the physical characteristics of the sand. Experiments show that the swell of dry sand measured after moistening by the addition of 2 per cent of water by weight may easily be 15 per cent. With like increments of water added, the volume tends to decrease to the saturation point. With a soaked sand, volume measurements become more constant. By this method the consistency of concrete can be more closely controlled. Experiments indicate that the compressive strength of concrete made of a given grading of aggregate varies inversely as the consistency of the mix. By the use of the inundation method of proportioning sand it may be possible to specify concrete by its strength rather than by its volumetric proportions. To my knowledge no practical adaptation has yet been made for using this method in actual construction, although there are no serious obstacles in the way of doing so.

The use of bulk cement has not been developed to the extent it could be. The standard sack of cement has been used so long in proportioning aggregates that the custom seems fixed. With storage bin facilities it is used successfully on both the central proportioning and central mixing plant types.

Curing

In the curing of the slab it is general practice to maintain moisture and temperature factors as near as may be at normal conditions. The top of the subgrade is kept moist, so that soil will absorb as little moisture from the concrete as possible. To retard evaporation and to reduce internal stresses, canvas canopies are placed over the concrete surface after finishing, or as soon as the concrete is sufficiently hard the surface is covered with water or moistened earth. These precautions make the rate of curing more uniform. The addition of reinforcement to the slab has no beneficial action in curing, as during contraction the steel has formed no bond with concrete.

Finishing

Considerable progress has been made in the development of the finishing machine. It is a labor saving device, and I might say a lifesaving device to humanely express its improvement over hand finish-

ing. By the use of such a machine a drier, consequently a stronger, concrete can be properly laid. The tamping action is particularly effective, tending to make a denser concrete and to flush grout to the surface for a smooth finish.

Design Details

The design of the pavement is not within the scope of this paper. There are certain details of design, however, that affect construction methods, not materially, but sufficiently to cause the builder some wonder as to how much work they will entail. I mention but a few of the most noteworthy developments. The central longitudinal point is generally placed to prevent a long crooked longitudinal crack. It is claimed that it increases about four times the beam strength of the half slab, acting as a beam. Steel dowel bars are placed transversely across the joint to act as tie-bars. The placing of the stiff dividing joint and the steel dowel bars in advance of the placing of concrete has not proven a drawback in the efficient prosecution of the work. Systems of steel reinforcement of the slab are now so fabricated that their placing above the subgrade does not interfere with other operations. The shape of the cross section on the bottom of the slab or the top of the subgrade has not been standardized. This detail works no particular hardships on the builder, however, as far as methods are concerned.

In regard to details of equipment some specifications require the use of steel side forms exclusively. This is quite necessary where a machine finisher is used. With the tendency towards concrete of firmer consistency, mixers are provided with accurate water gauging devices. Timing devices are also considered necessary. The boom and bucket system of distribution, after discharge from the mixer, is favored, as a drier mix can be used satisfactorily and segregation of aggregates prevented.

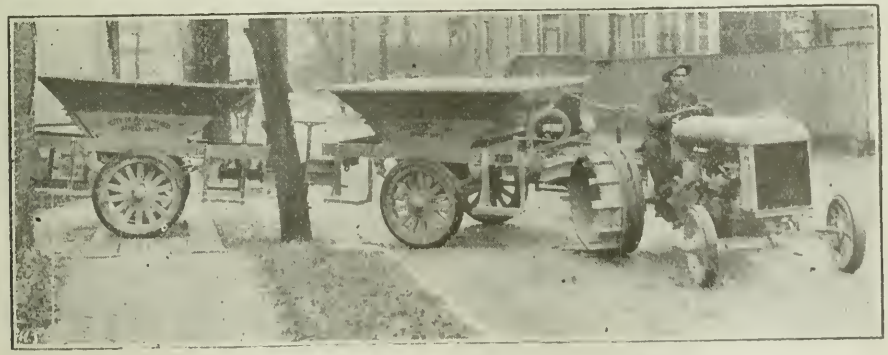
With the opening of the pavement to traffic the traveler is at once impressed with its riding qualities. The smoothness of finish, its freedom from uneveness are factors of prime importance to him, momentarily overshadowing the importance of the strength of the pavement. In specifications the limits of variation from a true surface are being drawn still closer. Expansion joints, where placed, must have their top edges truly flush with the adjacent concrete surface. Every detail of construction in fact is given painstaking care.

In conclusion a summation of the most striking developments that affect the methods used in this type of pavement would include the tendency towards the mechanical perfection of labor saving devices, plant co-ordination, security of material supply and large capital investments with a well trained and efficient organization.

The foregoing matter is from a paper presented at the Ninth Annual Michigan Conference on Highway Engineering at the University of Michigan.

MOTORIZED ASH COLLECTION AT RICHMOND, IND.

The equipment of eight Miami Fordson trailers and four Fordson tractors was purchased by the officials of the city of Richmond, Ind., through the Webb-Coleman Company, Ford dealers of that city. The transaction was completed by Mr. Paul James, sales manager of the Webb-Coleman Company, by actual demonstra-



ASH COLLECTION EQUIPMENT USED AT RICHMOND, IND.

tion of what the Miami trailer units would do when operated in trains with the Fordson tractor. They are pulling two trailers as shown in the illustration behind each tractor, through all the alleys for collecting ashes and rubbish of every description. The train is then pulled out onto the public dump where the load is quickly disposed of through the large rear doors in the trailers. These doors are controlled by two levers at the front of the trailers—one to dump the load, the other to rewind the doors.

The city is blocked off in four sections, two units being used in each section. Each tractor and train of two trailers is operated by three men—one to drive while the other two collect the ashes. This makes a continuous process for as soon as the first train is loaded—there is another train waiting for the loaders. The driver of the first unit goes to the dump at the rate of about seven miles per hour and is back again by the time the second unit is loaded.

In this manner each tractor and train of trailers replace two teams and two men, thus eliminating the old and costly method of two men riding on the wagon about half the day between the place the ashes are collected and the dump.

The capacity of each Miami dump trailer is 2½-tons, or 2 yds. rounded load, making a total load of the two trailers 5-tons, or 4 cu. yds. If at any time they should have occasion to use only one trailer, the second trailer may be dropped off at any point by simply operating the screw jack on the drawbar.

The city of Richmond, Ind., uses the eight trailers and four tractors for ash and trash collection in the winter time, but in the summer when this class of work is very light, it uses them for street repair or maintenance work. The city has its own sand and gravel pit from which it hauls gravel or sand for the unimproved streets.

The load can be spread evenly over the ground to any depth by simply adjusting the spreading device, or it can be dumped all in one spot as desired by the operator. In this manner the city officials have a complete unit which can be used the entire year for work as above described.

BIDS FOR ENGINEERING SERVICE

To the Editor:

The following advertisement is similar to several which have appeared in the technical press during the past two years:

"Bids wanted for engineering services for new water and light plant.

"Sealed proposals from experienced engineers will be received by the council of the city of ———— for preparing preliminary plans and specifications and furnishing estimates of the cost for a modern power plant. Such proposal to state experience and the applicant must furnish references and state amount of compensation for such service. The successful bidder will also be required to furnish a bond for such engineering service. All bids to be sealed and marked on the outside 'Bid for Engineering Service.' The right is reserved to reject any or all bids."

We would like to see a discussion of this problem in your columns in the hopes that possibly methods may be suggested which will tend to minimize the practice of calling for bids for professional services.

We have found that the governing bodies of municipalities advertising in this manner are interested mainly in the lowest bid received and only in a secondard ion in the reliability of the engineers they engage. This is particularly so when the engineer is asked to furnish a bond because it is hard for these authorities to see why a bond does not fully protect them and their taxpayers against inferior service and advice. In fact, we know of cases where towns have been particularly urged by engineers to call for competitive bids after their own particular proposition failed of acceptance. It seems to me that particularly all journals reaching public officials should discourage this procedure, pointing out that in reality they could afford best to employ the engineer who can command the highest prices instead of the one who will accept the lowest.

It is not necessary to state that on our part, we do not enter into competition of this sort on the basis of price but always put in our standard schedule. Is there not some way of protecting municipalities against the "cheap" engineer?

Very truly yours,

ARTHUR S. MILINOWSKI,

Of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn., Feb. 23, 1923.

EDITORIALS

THE ENGINEER AND CIVIL SERVICE

It is sometimes suggested that the employment conditions of engineers would be improved if all engineers in the public service were put under civil service regulations. An inquiry as to the wisdom of this procedure develops a wide difference of opinion among those who are best able to pass judgment on the proposal. Some are very strongly in favor of it and others are as strongly opposed. Some favor civil service only for the chief and others only for the subordinates. Even those of similar experience with civil service hold quite dissimilar views as to its efficacy. All of this confuses counsel and gives the detached observer pause.

All argue that civil service has its advantages as well as its disadvantages; the difference of opinion arises as to which outweighs the other. It is profitable to consider some of the pros and cons as advanced by distinguished engineers in their correspondence with the editor.

The principal argument favoring the placing of engineers in the public service under civil service is that it protects them against the spoils politician and thereby lengthens their tenure of office with corresponding opportunities for advancement in the service. Some deny this advantage, saying that where there is a will to remove an engineer a way can be found even if he has the protection of civil service. So widely do observers differ on this point that one is forced to conclude that what works well in one city does not work as well in some other cities. Where those in control of the situation are friendly to civil service and want it to work well it can and usually does work well, but where they want to beat it they can do so, although it is an obstacle to unrestrained favoritism. Where an applicant for a position must prove himself well fitted for it in a competitive examination before a competent and unbiased board, tenure of office becomes more secure and the appointment of personal or political favorites is reduced to a minimum.

The principal argument against civil service is that it is the last refuge of mediocrity. It is argued, also, that those who enjoy this form of protection pay rather dearly for it in lowered salaries, and that when men feel secure they do not function at their best and so are not worthy of greater compensation.

There is, of course, nothing novel in the suggestion as civil service is very far from a new idea. There has been long experience with it in some cities. It is worth while to find out why it works so well in some cities and so poorly in others. It is worth while to consider, also, if its apparent advantages are real and if these advantages can be secured equally well or better in some other way. Readers who hold opinions on the subject are invited to write them out for publication.

SIDELINES FOR THE ENGINEER IN PUBLIC SERVICE

Not long ago the editor suggested that engineers in public service might do well to take up sidelines to increase their income. This has been done frequently, of course, and the thought back of the suggestion was that it might well be done more generally. The idea was advanced in these words: "Every engineer has some spare time, some reserve energy and much latent ability which if joined to the other fellow's money, should provide the engineer an outside income. Some, but probably few, engineers have looked around a bit for this outside opportunity. If the engineer can earn something, and he may earn much, on the side, he will become more independent and more assertive of his rights as an engineer; his earnings from engineering will increase if he doesn't have to be too thankful for small favors. Engineers in public service have exceptional opportunities to achieve a degree of independence of engineering."

This suggestion has produced some interesting reactions from engineers in public service. The opinions expressed are by no means all favorable to the proposal. In fact, the weight of opinion is against it on theoretical grounds, although some modify their objections in view of considerations of practicality associated with

the means of subsistence. Some of the views advanced are here presented in brief.

One engineer admits the difficulty of reaching a settled conviction on the subject. Sometimes he feels that it is utterly wrong for a public employe to do outside work, but realizes that some of them must in order to make both ends meet. Another does not advocate the practice unless it is in connection with the promotion and advancement of his position in his profession. This engineer argues that sidelines keep the engineer satisfied with small salaries. Another argues that outside work is bound to broaden the engineer and make him of more value in his regular occupation. He says, also: "I like the suggestion that every engineer can readily find opportunities in which he can mix his engineering skill with the financial backing of the financier or business man to mutual advantage. In such instances the engineer's function is that of a promoter, at least that of investigator or planner. In this connection, however, we are almost certain to encounter opposition from engineers and employes who feel that an engineer employed on a fixed salary owes all his time and energy to his main job. This argument does have merit, though I am rather inclined to think that the points mentioned are of greater practical importance."

Another engineer, a highly respected veteran, points to the danger in sidelines, whether commercial or professional. It is difficult to do full justice to two unrelated lines, and where the sideline is professional it may become embarrassing or even compromising. He approves the idea to this extent: "There is one line of work which may be considered a sideline that is appropriate for an engineer in public service, and that is work as a consultant for the benefit of other governmental bodies who have work to do similar to his own. Such consulting work is not only profitable commercially but is beneficial to the agency that consults him and indirectly is of real value to the governmental body that regularly employes him. Such work really broadens his experience and his knowledge, and does not in any way interfere with real service to his regular employer." This seems a wholesome philosophy, yet even this does not leave everybody happy for the consulting engineer in private practice makes strenuous objection to it.

Another successful engineer in municipal service says: "I do not think it possible for a progressive engineer to avoid sidelines and in many instances this has been the only possible excuse for a man remaining in the public service. I think he should be encouraged to the limit, and I think there is no danger of excessive development as municipal administrations are as a rule jealous of such employes' time, and it is impossible to develop a sideline to excess."

One city engineer disposes of the suggestion with some finality in these words: "Our charter says that the city engineer shall devote his entire time to city business. Up to date I have found this requirement of the charter entirely unnecessary since I have had utterly no time to devote to any but city business. The strain on an engineer in public office is so great and the demands that the progress of the profession makes on his time are so considerable that both time and energy are lacking for anything beyond his work."

Another public service engineer says: "I do not believe that encouragement of sidelines is advisable. The best commercial organizations discourage sidelines for their employes upon the principle that a man should put all he has into his job, and that if his job does not demand all that he has he better get a new job."

One city engineer tells how this problem was solved in his city. At one time engineers in his department were in the habit of doing outside work, such as surveying for additions, for lots, grading jobs, etc. They derived considerable income from this work done outside of office hours. They generally used city equipment and there was always more or less criticism from outsiders, from other engineers, and some from the city council. At length the city engineer wrote a letter to the council asking for an increase in all salaries, showing what the members of the department were doing and what they were receiving for their outside work. He went into details on all the activities, showed what percentage of the cost of the work would be charged by practicing engineers and how much less the city was paying. This was good enough argument to produce results in the form of increased salaries. At the same time it was agreed not to do any more outside work. This plan has now been in effect for three years and is giving satisfaction. Perhaps the sidelines in this case worked out ultimately to the good of all parties and at this happy turn in the discussion we shall alight as gracefully as may be.

WRAPPING CONCRETE BRIDGE ABUTMENTS IN AN ASPHALT BLANKET

By J. F. Seiler, Engineer of Bridges, Wyoming State Highway Department, Cheyenne, Wyoming.

In recent years, and as a result of extensive highway development and construction, more and more study has been given to many of the minute details in connection with the design of roads and pavements, with a view to overcoming all of the defects which sooner or later appear as a result of non-attention to these factors. For example, studies of capillary action of water in various subsoils as affecting the bearing power of the foundation of the road, have been made, and there is no doubt but that even such a seemingly minute detail in the design of a road must be taken into account and properly provided for, if the best results are to be had.

In a general way, in bridge-work, the bearing power of the soil on which the structure must rest has been pretty well determined, and since, as a rule, foundations for bridges generally extend underneath the water table, such questions as noted above in connection with road design do not present themselves for solution to the bridge engineer. There are, however, many other problems equally as vexations, which affect that part of the structure hidden from sight and which, in turn, is the most important part of the structure. Reference is made to agencies which in one way or another attack and eventually destroy the foundations of bridges.

For many years it has been a matter of common knowledge that timber structures in sea-water are subject to the attack of marine borers, and treated timber has been largely used in an attempt to overcome their attacks, and more recently it has been discovered that certain mollusks penetrate even concrete coated piles, and tend to destroy such a type of protective coating. In many localities the soil in which bridge foundations are constructed is saturated with certain chemical salts which act upon concrete and often result in a complete disintegration of this most important part of the bridge structure. Most common of these salts is alkali, which occurs widely distributed throughout the Western States.

Such a condition was found to exist along the Powder River in Wyoming about 40 miles west of Casper, where it was proposed to construct a 100-ft. concrete bridge to carry the Yellowstone Highway over this stream. Near the site of the proposed structure, the C. B. & Q. Railroad crosses the same stream with a large concrete culvert carrying a heavy earth fill, and at various times the maintenance on this structure has amounted to a case of practically reconstructing the portions of this structure below low water elevation.

In view of these conditions, it became necessary to devise some means of protecting the substructure of the proposed bridge from the disintegrating effects of this strong alkali saturated soil. After much study the following plan was adopted:

A sub-foundation of 6 ins. of concrete mixed in the proportions 1:3:6, or known as Class "C" Concrete was laid down in the dry and allowed to take a firm set. Upon this dry sub-foundation a thorough swabbing of hot asphalt was put down, immediately after which a heavy burlap was laid, followed with another swabbing, and two more layers of burlap, each thoroughly swabbed with hot asphalt. The main footing of the abutment was then poured, followed by the walls and counterforts. The burlap blankets were cut large enough to permit of them being wrapped entirely around the footing and extending well up on the walls of the abutment and the entire surface beneath them thoroughly swabbed. From the upper extremities of the blanket, the walls and counterforts were painted with asphaltic paint up to a point well above low water. Both abutments and the central pier were similarly treated. Great care was taken in completely filling any spaces between the upper edges of the blanket and the concrete so as to obtain perfect adherence and thus prevent any spaces through which the alkali charged water might seep into the concrete.

The waterproof painting is generously thick and of excellent quality. It is believed that successful results will be obtained by this method of protection, the cost of which was very small indeed when taking into consideration the possibility of the entire loss of the foundations within perhaps less than ten years under other circumstances.

The Wyoming State Highway Department does not know of any other cases in which similar measures have been taken to protect concrete foundations, or in fact any measures at all, except ordinary waterproofing, which in this particu-

lar case was not considered sufficient. The department will therefore watch with a good deal of interest in the years to come, the effectiveness of this method of protecting underground concrete against disintegration. Figures covering the exact cost of this work are not just now available, as the contractors were paid for it under the item of concrete, but roughly speaking the cost was approximately 2½ percent of the cost of the entire bridge.

The bridge structure, consisting of two 50-ft. reinforced concrete girder spans on 14-ft. abutments and pier, together with the protection, was designed by the writer, and the work carried out under his general supervision. C. H. Bowman, District Engineer of the Department, and located at Casper, was in general charge of the work, with J. S. Manion, Resident Engineer, in direct charge. Contractors were the Security Bridge Company of Billings, Montana, who executed all the work to the complete satisfaction of the department.

CONCLUSIONS REACHED AT PENNSYLVANIA CONFERENCE OF REPRESENTATIVES OF 25 STATE HIGHWAY DEPARTMENTS

Selection of road types with some idea of the use to which the road will be put, removal of State Highway departments from politics, a tax on gasoline so road users will pay for road construction and maintenance in direct ratio to the extent they use roads; a traffic survey in each state; uniform motor legislation, and elimination of all grade crossings, are recommended to the American people in the report of the Conclusions Committee named by the highway conference recently called by Governor Gifford Pinchot, of Pennsylvania.

Road officials from 25 states met in Harrisburg and for two days discussed highway problems. To summarize the conclusions of the conference, a committee was named, of which Thomas H. MacDonald of Washington, chief of the Federal Bureau of Roads, was chairman. Other members were Col. Frederick Stuart Greene, highway commissioner of New York; Chief Engineer A. W. Dean of the Massachusetts Highway commission; Frank Page, chairman, North Carolina Highway commission; Paul D. Sargent, chief engineer, Maine; Clifford Older, chief engineer, Illinois; H. G. Shirley, chairman of the Virginia Highway commission; Charles J. Bennett, commissioner, Connecticut; and William H. Connell, assistant state highway commissioner of Pennsylvania.

The report of the conclusions, committee is as follows:

Administration

The construction, maintenance, financing, and operation of highways is becoming more and more a question of nation-wide transportation and less one of neighborhood convenience. There are two general phases to every problem coming before a state highway department for solution—the business and the technical. A majority of the states have recognized this fact by providing for either engineer commissioners or technically trained engineer executives. We believe this principle is sound fundamentally and urge the state authorities, both executive and legislative, to provide at all times strong engineering control in the administrative and executive work of their state highway departments and engineering supervision of the construction, maintenance and operation of the highway systems.

To this end we urge that these departments be removed from political influences, and that continuity of service be preserved for a sufficient period to insure stabilized policies. In no other way is it possible to safeguard and protect the interests of the citizen who is paying for the roads.

State highway departments, with their knowledge of the geography and topography of the states, should determine without legislative or other interference, what roads or systems of roads should be constructed and maintained with state funds and should not be governed by legislation as to types and cost of construction.

Finance

The highway departments should be operated under a budget system.

The cost of building and maintaining an adequate system of highways should be distributed equitably among the sources of highway revenue in proportion to the benefits derived from the improvement.

The permanent features of original construction of highways should be financed on the "pay as you go" plan or from the

proceeds of serial bonds, according to the stage of development of the highway system now existing in the several states.

The policy of requiring the user of the roads to pay for the service received through a license and gasoline tax is a sound one, and all revenues from such sources should be applied primarily to the maintenance and reconstruction of highways.

Construction

Owing to variations in climate, soil, traffic conditions and available materials, no one standard type of pavement is practical for the country or even for a state.

Granite block, brick and bituminous tops on a concrete foundation, and a concrete pavement may be termed as construction of the first class; the so-called flexible types of pavements may be termed as construction of the second class; and gravel, sand and clay or other top soil may be termed as construction of the third class.

The progressive method of construction, whereby the grading, structures and drainage are first completed and the hard surface pavement laid later, is both practical and at times the most advantageous method of highway construction.

Maintenance

Unless adequate maintenance is provided for, initial construction of highways should not be undertaken at all.

The same engineer who builds the road should be held responsible for its upkeep.

Traffic

Each state highway department should establish a traffic bureau to make a highway transport survey in all its phases to determine present, and forecast future, traffic conditions to assist in the selection of the economic road construction.

Efforts should be made, in co-operation with motor vehicle officials, to establish as soon as possible, uniform motor vehicle laws and regulations, so that the user of the road may travel under uniform laws wherever he goes.

It is highly desirable that a uniform law be enacted by the states of the union regulating the dimensions of motor driven vehicles and the wheel load of such vehicles.

An effort should be made to provide proper standard devices for the protection of the road user and the prevention of accidents, and no person should be allowed to operate a motor-driven vehicle upon a public highway until such driver has been examined and a license showing competency has been granted.

We believe in the installation of simple, easily followed direction signs.

A more determined effort should be made promptly to eliminate all grade crossings.

Realizing the grave responsibility resting upon the officials charged with the administration of the highways for the safety of the public, we earnestly appeal to the people at large to aid in making these conclusions effective.

ARE CITY MANAGERS ATTEMPTING TOO MUCH?

By John F. Druar, of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn.

A number of years ago, the writer became enthusiastic over the scheme for the employment of City Managers for communities from the smallest villages to the largest cities and believed that capable, well-trained men should be used in this connection. Since that time, a considerable development has taken place, and we now have a large number of municipalities under the city management scheme. This is all very well and has resulted in considerable economy up to this time. However, a word of caution should be given the city managers and prospective city managers as to the conduct of their office.

It has come increasingly to the writer's notice that the city manager, as a usual thing, is becoming too ambitious, and I believe this is detrimental to all systems of city management. It is understood that I am not attempting to disparage city managers but rather encourage them along the management line. Many of these men are engineers who have had an engineering education, with perhaps not much practical work or much chance to apply their professional knowledge. In other words, they lack the broad experience necessary to design engineering work. They naturally have but a small amount of time to devote to any one object or any particular improvement other than to manage the financing and the large number of details in connection therewith. From loss of association with engineering works, even though they may

be experienced engineers, they are unable to know costs, the advance of the science and other things known to the consulting engineer who is handling many different classes of work of varying natures every day in the year.

There is no place where it is possible to point out the savings that can be made in the proper handling of engineering work other than the way in which it has been executed. In other words, it may, and usually does, cost a municipality a much larger amount of money to have the city manager prepare plans and specifications for certain work than it would to have these plans and specifications prepared and the work supervised by a consulting engineer in regular practice. This fact never comes to the surface as there is no chance of making a comparison as to what the work should cost.

The fact is the consulting municipal engineer of today, if he is worthy of the name, is able to draw plans, specifications and complete designs and supervise construction in such a way as to eliminate all unnecessary expense in the projects. Not only does he make a particular study with all the data he has in mind of previous situations but in the course of his career, through his experience with perhaps one or two hundred clients, he has naturally made some mistakes from which he has learned how to avoid their repetition. The ordinary city manager has perhaps designed several successful plants which he may or may not have done in an economical manner. He is not in a position to determine these points as he has nothing to compare with in his daily work nor does he have the time to make such comparisons and studies. Therefore, the live and wide-awake city manager should hesitate a long time before attempting engineering designs. His hands are full of other work and his brain acting along lines which would not contribute to economical engineering design.

In other words, I believe that the city manager is attempting to handle more work than he should and is entering the field in competition with the consulting municipal engineers, and this only means disparaging his management by so doing. The city manager should be the first to recognize the necessity of securing first class consulting engineers for the purpose of the design and execution of public work and should be the first one to suggest such employment. This does not show a weakness on his part, but rather a strength of character which will be reflected in his duties as city manager. In other words, I believe that the city manager of today should be the first man to recognize the advisability of the employment of experts in all branches when such services are required, and should not, himself, attempt the solution of engineering problems. Should he do this, there is not a first class consulting engineer in the country who would not recommend to his municipal clients the employment of well-trained city managers as a solution of much of the unwise expenditure of money now taking place in the municipalities and the gathering up of loose ends of public administration.

THE PUBLIC UTILITY FUEL PROBLEM

By C. M. Roos, Secretary-Manager Cairo Water Co., Cairo, Ill.

During the world war fuel was among the many commodities needed for the proper carrying on of the great struggle, and without murmuring our people submitted to all sorts of inconvenience and paid exorbitant prices for essential commodities. It is one of the characteristics of the Spirit of America to which we point with pride, to be willing to pay dearly for victory in maintaining her position as the champion of liberty and justice. But that same spirit frowns upon unfair, unjust or unnecessary conditions which fail to protect or recognize the welfare of the majority in order that a small minority may enjoy special industrial or commercial privileges.

Coal prices were high during the war and there was a reason for it which was understood and accepted by our people. Coal prices since the war have averaged or ranged even higher than during the war, and there is also a reason for it, but that reason is well enough understood to warrant the uncompromising statement that the present high prices for fuel are unnecessary and unwarranted.

This statement is not made to place the entire responsibility for high coal costs upon the retailer, the transportation lines, the miner or the mine operator; neither can the entire blame be charged against all of these classes collectively. The condition exists as the result of failure thus far on the part of our Government to adopt a sane and common sense plan to regulate and direct the coal industry

which has such a vital place in our entire economic structure.

The coal situation as a whole is one which, without any one group within the group being responsible for results, runs away with itself, defying interference, resenting criticism and comment, and doing all sorts of damage.

The author of this paper recently made an attempt to show the necessity for regulation of the coal industry, comparing the industry with our public utilities, all of which are now to a greater or less degree under some form of government supervision.

On account of the rather uncompromising manner in which the subject was treated, this article attracted widespread attention and comment, part of which is very interesting and amusing. Coal men as a whole resented the fact that a mere consumer dared express himself in regard to the coal situation. Some looked upon it as a case of "sour grapes," that because the public utilities have been caught within the merciless meshes of public regulation, they now desire to drag down to ruin with them the coal industry.

Regardless of misunderstood motives, and regardless of well meaning, conscientious and absolutely honest individuals and departments in the coal industry, the present status of the conduct of this industry as a whole is basically wrong, and it should be remedied in a safe and sane manner. It should not be a difficult task to accomplish this.

In its recent report to the President of the United States the Federal Coal Fact Finding Commission discusses its investigations at some length, and then sums up the situation by stating that the coal industry in our country is overdeveloped, with too many mines and too many miners. Figures and statistics are given to prove this statement. Each ton of coal purchased by the consumer must carry an exorbitant charge to cover the cost of overdevelopment in the coal industry as a whole.

It is obvious to anyone that the remedy for such a condition must lie in regulating the number, location and character of mines, and when the mining wage scale is properly and fairly adjusted or handled, the problem of an excess number of miners will take care of itself because everybody will not want to be a coal miner as at present. When a man can earn more money digging coal a few hours per day than the salary received by the executive head of some struggling industry, it is easy to answer the question why we have almost double the number of coal miners that are needed. An excess number of miners is just as much a contributing cause to the present coal situation as an excess number of mines.

Effect of Coal Prices on Water Utilities

The average water utility is probably affected more by fluctuations in coal prices than other industries, for two reasons:

(a) Power is the largest single expense item of the average water works.

(b) The margin of profit allowed water utilities by our regulatory bodies is smaller and less flexible than any other class of utility.

Power is coal, whether used directly from a utility's own power plant or otherwise. Changes in water rates are very expensive and difficult to secure. Sudden fluctuations in coal prices (and a coal price fluctuation is usually upward), leave the utility without a margin to cover such increased expense.

Fortunately many water utilities are located within almost a stone's throw of coal mines, with the result that when the coal pinch comes they can manage to buy, borrow or steal fuel on some basis within reason. Water utilities not so favorably situated have a different story to tell.

The Cairo Water Works Coal Story

The story of the Cairo Water Works and its 1922 coal supply may be of interest and even if it is not instructive it may be at least entertaining and is a strong argument in favor of proper regulation of the coal industry.

It is not without the full knowledge that it is not thoroughly orthodox to fill our organization's records with other than technical statistics and figures, that this story is given. Amusement is a delicacy, however, for which we sometimes pay dearly, and it may be worth having a paper "ruled out of the records," to be able to mix in with the serious deliberations of a pious group of water works men a story which savors more of romance as it is viewed from a distance than as experienced at the time by the one on the ground who played the leading role.

Cairo is often thought of and referred to by "outsiders" as a place "With water, water everywhere and not a drop to drink." That part of this statement which refers to the water is always persistently disputed and resented by all blue blood Cairoites, as they will proudly tell of the greatest levee system in the world and to the only city in the river valleys which has never been flooded.

The proper statement which some have confused with the water story is "Coal, coal everywhere and not a pound to burn." In 1922 there was coal to the right of us, coal to the left of us, coal in front of us and coal in the rear of us, and it also volleyed and thundered. From the blood curdling Herrin massacre to the rumblings of the uncontrolled passions in the Kentucky coal fields, bloodshed and riot were the order of the day. Coal deposits in almost unlimited quantities are to be found in Illinois just north of Cairo, also in the Kentucky coal fields just across the Ohio river, and in the coal fields up the Ohio river from which shipments are made by river barge.

The water works man needed fuel to avoid breaking a record of operating his plant continuously without a single shutdown for ten consecutive years. Wise looking veteran coal men kindly advised him that he need not worry, that the coal strike would not last long, and added the old threadbare statement, "the people and the government will not stand for it."

When the coal shortage and high prices led the water man to decide that action was more virtuous than discussion and watchful waiting, he acted and acted entirely upon his own resources without the direction and legal assistance of engineers or lawyers, or the aid of a report from a fact finding commission.

His first move was to secure a nearby tract of hardwood timber, lease a portable gasoline operated wood sawing outfit, and organize a bunch of husky wood cutters. The wood was cut into 30-in. lengths and shipped in carload lots to the waterworks switch. As soon as this plan was well under way and success was assured, the horizon was scanned for other worlds to conquer as it was discovered that to burn wood to good advantage coal must be mixed with it. Coal then was the next thing needed, and there was no disposition on the part of the water man to pay $14 per ton for a product which should sell for not more than $2.50. The only solution seemed to be to go to the coal fields and actually dig the coal from under the ground. It was soon found that coal above ground was a product so madly sought and still more madly manipulated that a water works man and his purse couldn't last long under such conditions.

The Herrin massacre instinctively led the would-be coal miner to turn his face southward instead of northward as he gazed wistfully into the distance looking for something like coal at less than $14 per ton.

Early one morning while the rest of the world remained asleep, mounting his trusty steed in the form of an old Maxwell auto, the daring prospector, true to style with a gun in the tool kit, started out into the wildest, rockiest, roughest part of Kentucky in search for coal. After many weary days of arguing, negotiating, and prospecting around sections where rioting and bloodshed were almost daily occurrences, coal began to move to Cairo in cars marked "Cairo Water Company."

The story of personally shoveling coal, dodging the suspicious and prejudiced coal miners, employing farmers with teams for as much as $20 per day to haul the coal to the cars, being in a section where checks would not go, making it necessary to carry actual cash on one's person to meet the necessity of paying labor every night, etc., would be too long to include in an article like this. But results were obtained.

The rather spectacular efforts herein referred to could have been avoided if the water works management had felt justified in raising funds with which to buy coal at $14 per ton and operate the plant at a great loss. The action as taken was prompted by a determination to win in a fight against an outrageous condition in the coal industry, which should not have been allowed to exist and for which there was no real excuse.

As part of the proof of the results obtained by its most unusual methods, the Cairo Water Company's fuel account for 1922 shows an average cost equivalent to $3.87 per ton for coal, including from $1.25 to $1.50 freight rate per ton, and 10 cts. per ton for unloading.

We have no coal strike in 1923. The average coal costs thus far this year, however, for this same plant are just about as high as in 1922.

The serious question before the water utilities in Illinois is, are we satisfied to sit in silence and not endeavor to find some way to reduce our fuel or power costs? Is there not some way by which our interests can be better served by combining our coal buying or procuring powers? With an abundance of coal within such easy reach, at our very doors, do we not have the initiative, ability and power to get enough of it to run our plants at a fair price?

The foregoing paper was presented at the recent annual convention of the Illinois Section of the American Water Works Association.

RIGID "STANDARD" PRACTICE VS. COMMON SENSE

By George C. Warren, Chairman Executive Committee, Warren Bros. Co., Parkman Bldg., 9 Cambridge St., Boston, Mass.

Deeply interested in two unusually valuable articles in Municipal and County Engineering, issue of November, 1922, I hope an addition to the subject may be of value and interest to both practical and technical road construction men. I refer to the articles:

1. "Standard and Standardization," etc., page 162, by the always practical and forceful pen of one of the fathers of high grade street construction—George W. Tillson, C. E.

2. "How Good Roads Developed Polk County, Florida," pages 171-172, in which special reference is made to the extraordinary and great non-standard "Bartow Clay" foundation as a prime cause of economical construction both as to Polk County roads and city pavements of Bartow, which is the county seat of Polk County.

Illustrative of the essence of the present consideration may I quote two sentences from Mr. Tillson's timely and highly practical article as follows:

"One point must be considered here. A standard is supposed to be the best of its kind. But in practical work what is theoretically the best is not always economically so. The writer was once called down quite severely by his professor in college when in an essay on 'Foundations' he made the statement that rock makes the best foundation, the professor's argument being that oftentimes sand is as good as rock.

"The writer has always been strongly in favor of standards and standard specifications, but wishes to reiterate what he has previously said that they should be used understandingly with a knowledge of why this thing or that is required, so that any omissions or additions may be made without producing a document that would be inconsistent and of little value."

1923 VIEW OF WARREN PAVEMENT LAID ON BASE OF "BARTOW CLAY" ON MAIN ST., BARTOW, FLORIDA, IN 1914.

Very many engineers hew too closely to text books and more or less theoretical lines rather than provide practical variations from them to meet peculiar local conditions economically, both in writing specifications and in carrying out construction under them.

Bartow Clay

This brings us to the "Bartow Clay" matter. There is probably no text book writer or college professor who would have thought of suggesting this as a first class foundation for high type, expensive road construction which it has proved to be. We quote from the article:

"To keep the cost down, local products were used almost exclusively in the construction work, the clay being taken from the Bartow clay pits and local soft phosphate rock being often used for the base."

The writer's attention was first brought to this material in the year 1913, when he was asked advice as to whether or not it would make a suitable foundation for the Warren pavement it was proposed to adopt in Bartow. The material was described as a soft phosphate clay, which could be ground and if brought to the street in quarry-sizes, up to say 10 ins. and spread on the sub-grade it would so crush under the roller as to provide a solid roadbed of uniform contour, even resembling Portland cement concrete in appearance.

The drainage was reported as good. The writer hazarded the opinion, that while contrary to all established standards and rules governing road construction, such material would prove to provide splendid foundation for dense stable bituminous wearing surface, even under heavy city traffic. The result has been more than satisfactory, as shown by the following quotations from a letter, dated Jan. 13th, 1923, from Mr. J. W. Greer, City Manager of Bartow, and the accompanying photograph sent by him:

"The bitulithic pavement you put down here in 1914 on Bartow Clay foundation is in fine shape.

"I have examined the paving closely and have also examined into the merit of the Bartow foundation. From the length of time the pavement has been down and the fact that it is on the Main Street of the City and in both the business district and the residence district, and the further fact that all the business traffic and the haulage and passenger traffic to and from the union railway station is done over this pavement it would seem that the Bartow Clay foundation is all that could be desired and the pavement first class in every respect.

"There are no cracks, either transverse or longitudinal, no folds or ravels in the pavement and the topping seems as perfect as when placed barring the slight wear from constant use for eight or nine years."

Characteristics of Bartow Clay

The following additional information with reference to Bartow Clay is from a private report by George O. Tenney, President of the Atlantic Bitulithic Co. of Washington, D. C., dated March 2, 1922:

"This Bartow clay is mined by blasting and comes out in chunks. We hauled it to the street and leveled it off, but the surface was very irregular. We then wet the phosphate clay in the street and allowed the water to dry out somewhat before putting on the roller. We were then able to smooth out the surface, as the water melted down the lumps.

"Before the clay had thoroughly dried out, we scattered 1 in. stone over the surface so as to about half cover the surface and then thoroughly rolled it, squeezing the stone down in the phosphate clay. After the street had been thoroughly rolled, and it had entirely dried out, it looked exactly like a concrete foundation. This is an exceptionally good material for a base; in fact I hardly believe any other material would be anywhere near as good. As a general proposition in the location of Bartow, this clay is being used without the addition of the stone."

IOWA TRANSPORTATION PROBLEMS AND SUGGESTED SOLUTIONS

By C. C. Coykendall, Assistant Chief Engineer, Iowa Highway Commission, Ames, Iowa.

Iowa's highway transportation problem, briefly stated, is that of improving and maintaining a rural highway system of approximately 104,000 miles in a manner adequate to traffic needs. No small problem, it must be admitted, but by no means one impossible of solution. The one and only really essential thing necessary to make the solution of this problem an absolute certainty is for the people of Iowa to decide that an improved system of highways is really needed in Iowa. When that decision is reached, the speed with which highway improvements will be accomplished in Iowa will amaze the most optimistic good roads enthusiast.

Money Can Be Raised

Ample proof is easily found for the accuracy of the foregoing statement. During the last decade approximately three-quarters of a billion of dollars of Iowa money has been invested in automobiles. Annually we are spending approximately one hundred million dollars in renewing and increasing our motor vehicle equipment. Evidently Iowa feels that she needs automobiles. School taxes are now being paid at the rate of fifty million dollars

annually, and how many really serious grumbles do we hear on this account? How many forward-looking, serious-thinking persons believe that there is any prospect of our school taxes being lowered? Not one. As the years go by our expenditures for educating the youth of the State will steadily increase. For Iowa long ago decided that her children need and are entitled to educational advantages second to none. All over Iowa, in county, town and city, many millions of dollars are being spent annually in building modern, comfortable homes. The people of Iowa have decided that such homes are needed and are proceeding to build them. Why, then, should our highway transportation problems alarm us? A study of the problem shows that it consists entirely of providing adequate and equitable means of financing road improvements, and Iowa has in many ways demonstrated her power to pay for what she needs.

Highway Progress in Iowa

In order that a proper understanding of our highway transportation problem may be had, a brief statement as to what has been accomplished toward the improvement of our highways is in order. Actually, much more has been accomplished than most people realize. Outstanding and fundamental among these accomplishments is the classification of highways, from a consideration of the traffic served, and the fixing of responsibility for the improvement and maintenance of the various systems into which the highways have been classified.

The Primary System

At the present time our highway system is classified into primary and secondary roads. Approximately 6,615 miles of main highways are included in the primary system, and the remaining mileage is included in the secondary system. The primary system includes the roads of state or interstate importance, and is the system upon which, by Federal statute, Iowa's share of Federal aid appropriations must be expended. Responsibility for the improvement and maintenance of the primary system is vested jointly in the county boards of supervisors and the State Highway Commission.

The Secondary System

The secondary system is further classified into county and township highways. Approximately 11,000 miles of the secondary system, including the roads which are of importance from a county standpoint, are county highways, and are under the direct supervision of county officials. The remaining mileage of approximately 87,000 miles is in the township system and is under the jurisdiction of the township officials. Inasmuch as the primary road system is the system in which the state as a whole is most interested, and is the system which carries a very large percentage of the total traffic upon the highways, we will first consider the problem of improving the primary road system.

Improving the Primary Roads

Of the total mileage of 6,615 miles of primary roads, when work now under contract is completed, there will remain approximately 2,750 miles to be constructed to established grade and the necessary drainage and drainage structures installed. Approximately 335 miles of this system have been paved, and approximately 1,560 miles have been surfaced with gravel. It will thus be seen that real progress has been made toward completing the construction of roads to established grade—a necessary preliminary step, whatever the nature of the ultimate improvement—some progress has been made toward the gravel surfacing of the system,w hile the hard surfacing has barely been commenced.

Differences of Opinion

In considering the further improvement of the primary road system, let us first attempt to determine definitely what we are striving for. It is always well at least to think that we know where we are going before a start is made. Anyone who has made any study of the primary road problem in this state finds that there is a wide difference of opinion as to what type of improvement is necessary properly to take care of traffic upon the primary road system. Practically everyone will admit the necessity of having the primary road system graded, drained and bridged. Some, however, will not admit that there is any necessity for any pavement or any type of surfacing whatever. Others are against a paving program but consider a gravel surfacing as the ultimate and final solution. Still other enthuusiasts insist that no type of surfacing for the primary road system is worth considering excepting a pavement.

When Paving Is Economical

None of the attitudes above outlined, toward surfacing the primary road system, is the reasonable attitude. Those opposed to any type of surfacing are wrong. We cannot afford to have the 500,000 automobiles now owned in this state made useless with every heavy rain. The best

dirt road that can be built will not adequately serve traffic upon any part of the primary road system. The fallacy of the argument that a gravel surfacing is all that is needed on our primary road system, lies in the fact that gravel roads carrying a very heavy traffic cannot be so maintained as to give service comparable to that given by a paved road. Some gravel road enthusiasts argue that gravel roads can be built and maintained indefinitely at a less annual cost per mile than can paved roads, but what does this prove if traffic is not equally well served? Extensive investigational work recently carried on to determine the tractive resistance of various road surfaces, conclusively proves that it takes less fuel to operate motor vehicles on paved roads than on gravel roads. Consequently, when traffic upon any highway becomes sufficiently heavy, the saving in fuel costs to users of the highway makes it economical to pave it rather than to maintain it as a gravel road. The paved roads enthusiasts who insist that all of the primary road system must be paved and that no other type of surfacing should be considered, are wrong. The traffic upon all portions of the primary road system is not such at the present time as to justify the cost of pavement.

It is believed that the proper solution for the problem of improving the primary road system is by paving those portions of the system where traffic is heavy enough to justify paving, and surfacing the remaining mileage with gravel or similar material.

If one takes a map of the primary road system and is familiar with traffic conditions, it is not difficult to lay out a network of roads that should be paved. This system when completed will carry practically all of the interstate traffic and will also serve a large part of the traffic that might be classed as through traffic though confined to the limits of the state. A logically laid out system of paved roads must also include a number of heavily traveled roads radiating out from cities even though such roads may not be of much state or interstate importance.

In order that the problem might be reduced to definite terms, such a system has been laid out and tentative estimates of cost prepared. The proposed system of paved roads includes approximately 2,100 miles, and the program proposed includes the gravel surfacing of all the remaining mileage. It is not contended that the system proposed is perfect, or that anyone else would lay out identically the same system for improvement. Suffice it to say, however, that such a system as has been laid out and estimated, would provide a very usuable system of highways and would serve as well as any other system as a basis for discussion.

Five-Year Construction Program

Obviously, the carrying out of such a program must involve a considerable period of time, and for this reason it was assumed that the construction program would extend over a five-year period. During this five-year construction period, 2,748 miles of road must be built to established grade, 3,465 miles must be gravel surfaced, and 1,740 miles of pavement must be constructed. During this construction period adequate provision must also be made for taking care of all needed maintenance work. With this in mind, let us inquire into the difficulties likely to be encountered in the carrying out of such a program.

From the standpoint of construction facilities available, the grading, draining and bridging required to complete this class of work on the primary road system can readily be accomplished in two years. During 1922, 1,070 miles were graded, drained and bridged, and this performance could easily be increased sufficiently to build the 2,748 miles yet remaining, in two years. There is available for work in this state a large, well-equipped construction organization, capable of completing any reasonable amount of this class of work that can be offered. The only possible difficulty that might be experienced in carrying out the graveling program is in securing the necessary open-top cars for transporting surfacing material, inasmuch as a considerable portion of the mileage to be gravel surfaced lies in territory where surfacing material must be shipped in. The question of rail transportation, however, is the only possible difficulty in carrying out a gravel surfacing program of this size in five years. There seems to be no limit to the ability of gravel surfacing contractors to expand their facilities to take care of any amount of this kind of work within reason.

It is not thought that any difficulty would be experienced in constructing the 1,740 miles of paved road during the five-year period. The contracting facilities for constructing this class of improvement have greatly expanded during the past three years, and we now have within this state a competent contracting organization capable of building annually at least

400 miles of rural highway pavement. Substantial progress has also been made toward the development of the material resources of the state, and there is no question but that if a definite paving program could be authorized, the development of necessary materials would proceed rapidly and readily care for such a program as has been outlined.

From the administration and engineering standpoint no difficulty would be experienced in carrying out such a program. But little preliminary engineering work is required for carrying out a surfacing program after the system has been built to established grade. The present engineering, and the necessary expansion of the organization to take care of such a construction program could readily be accomplished.

Problem of Finance

The only apparent obstacle, therefore, to the carrying out of the program as outlined above, is that of financing it. Careful preliminary estimates of cost of the program as heretofore outlined, together with the necessary allowance for maintenance, shows an expenditure, based on present costs, of approximately $95,000,000 during the five-year period over which this construction program would extend.

It is estimated that the revenue becoming available in the primary road fund during this five-year period will total approximately $55,000,000. This estimate is based on the assumption that receipts from Federal aid and the licensing of motor vehicles will continue at the present rate, and that this fund will be supplemented by revenues derived from a tax upon gasoline, which will net the primary road fund one and one-half million dollars annually. The levying of a tax upon gasoline is not essential to the success of the program, but would reduce the outstanding indebtedness at the end of the construction period by seven and one-half million dollars. Incidentally, it will be noted that no special assessment is proposed in connection with the paving program. Based on these assumptions, the difference between the estimated expenditures and estimated receipts during this five-year construction program is $40,000,000, or approximately 80 per cent of what Iowa is annually paying for school taxes.

It should be made possible to finance this entire program from the primary road fund with no property tax or assessment of any kind, by anticipating future allotments of primary road funds, either through the issuance of certificates or bonds in those counties where the construction program amounts to more than the estimated revenue during the five-year period. Such certificates and bonds could be made wholly payable, both as to principal and interest, from the primary road fund, thus eliminating entirely the property tax feature.

It is not thought that the system of pavements as above outlined is by any means the ultimate mileage of paved roads that will be needed for carrying the traffic of Iowa. Rather, this mileage should be considered the minimum. At the end of the five-year program, without question a continuing program of paving construction would develop on those roads where traffic developments were such that the traffic could no longer be economically served with gravel or sand-clay surface. It is believed, however, that the program as outlined has this to recommend it: First, it does not involve an expenditure sufficiently large that it should in any way terrify the people of the state. Second, it provides a system of unsable roads in what is probably the minimum amount of time.

If funds should be provided in sufficient amount to pave the entire mileage of the primary road system, it is doubtful whether the task could be accomplished in less than eight to ten years. If it were, we would be making more rapid progress than any other state where large paving programs have been authorized, and that at a time when neighboring states have similar programs under way and would be competing for the materials, construction facilities, and rail transportation so necessary to the success of such a program. It is believed that the most urgent need of road users in Iowa at this time is a system of usable roads completed at the earliest possible date. For that reason this program proposes the immediate gravel surfacing of roads that within the next decade will require paving if traffic is to be efficiently and economically served.

It must be borne in mind that the program of improvement herein outlined for the primary road system is only one of many solutions that might be offered, and is not necessarily the most feasible one. The scheme proposed, however, involves no radical changes in existing laws and could be put into effect with a minimum of delay or confusion. The most important changes that would be required in existing laws to put such a program into effect would be in those sections pertain-

ing to the anticipation of future allotments of the primary road fund through the issuance of certificates or bonds.

In considering our highway transportation problems, we must not lose sight of the needs of our secondary road system. No state has provided adequate laws under which highways may be built, until provision has been made whereby any community may, if desired, improve the roads of the community in a manner adequate to traffic needs. In this particular the lawmakers of the State of Iowa have failed, inasmuch as under existing laws it is impossible for any community to make reasonable progress toward the building of an adequate system of community roads.

Financing Secondary Roads

There are two commonly accepted benefits resulting from the improvement of any system of roads—a community benefit and a benefit to the road users. If these two benefits are to be recognized in apportioning costs, it must follow that the cost of improving a system of community roads must be borne largely by the people living in the community served by those roads. If this is true, then the solution of our secondary road problems will be found through providing more adequate revenues for financing secondary road improvements, and efficient means of administering secondary road work after adequate finances have been provided.

As one solution for the secondary road problem, I would propose placing all secondary roads under the supervision of the county board of supervisors and county engineer. Inasmuch as county roads are of county-wide importance, the distinction between county and township roads should be continued and county road improvements should continue to be financed largely from tax levies spread over the entire county. Provision should be made whereby the people of the county could, if desired, anticipate county revenues through the authorization of bond issues, in order to more rapidly complete the adequate improvement of the county road system.

Financing Township Roads

Improvement on the township road system should be financed from the proceeds of a tax levied upon all property in the county, outside of the incorporated limits of cities and towns. The provision for the creation of secondary road districts in order to facilitate the improvement of secondary roads—both county and township—should be continued, with provision for assessing at least one-half the cost of surfacing against benefited property, instead of one-fourth of the cost as the law now provides. Improvement of secondary roads might be further stimulated by applying one-half the revenue derived from a tax upon the sale of gasoline toward the maintenance and improvement of secondary roads. An efficient organization and equipment such as the county could place on township roads would produce better results for the same expenditures than are now being secured. In addition to this, the county officials would probably levy township road taxes much more nearly approaching the maximum allowable than do the township officials. Such a policy might not be particularly popular with certain taxpayers, but it would produce more revenue for building township roads, and more revenue must be produced if any progress is to be made toward the improvement of the township road system.

The foregoing paper was presented at the recent annual meeting of the Iowa Engineering Society.

REHABILITATING OLD SEWER SYSTEMS

By William E. Stanley, Assistant Engineer, With Pearse, Greeley & Hansen, Consulting Engineers, Chicago, Ill.

The object of this paper is to present some observations regarding the present status of the sewer systems in many cities of this country; to point out briefly some of the underlying causes which have brought them to such a condition in their operation that we may term them "sick sewer systems"; to point out some of the symptoms of such a condition; to suggest general remedies; and to illustrate the application of these suggested remedies by reference to a number of typical cases which have come to our attention during the past few years.

General

The first sewerage plans to be prepared for a city in this country appear to have been for the city of Chicago. About 1855, Mr. E. S. Chesbrough was selected engineer for the Chicago Sewerage Commission to design a system of sewers for that city.

Following Chicago, a few of the larger cities had sewerage plans prepared. However, the construction of sewers for the smaller cities did not become active gen-

erally until after the publication in 1881 of Rudolph Hering's report to the National Board of Health, giving the results of an investigation of the sewerage systems of several European cities. Sewers began to be built in a great many cities about 30 years ago. These systems have been added to at intervals as the cities grew.

Design and Status of Many of the Present Sewerage Systems

Many of the sewers built have been constructed without any regard to a general comprehensive plan. The tendency has been to build in a haphazard way each section of sewer to meet the needs of the moment only, or to suit the whim of some person with little or no engineering knowledge and with no plan for future extension.

Some cities had sewerage plans prepared and either lost or ignored them. Not all, however, of our present sewer systems were built without comprehensive plans. A considerable number of cities had careful plans prepared by able engineers who considered the future development of the city. The cities which followed definite plans in the construction of sewerage systems have escaped the ever increasing troubles encountered by the communities with the haphazard systems. The original plans for the cities of Superior, Wis., and Elgin, Ill., among others, are examples of some of the earlier comprehensive work.

At Elgin, Ill. we have had occasion recently to look over the plans for sewerage prepared by Samuel M. Gray in 1892 and have found them remarkably well fitted to the present needs of the city. Present troubles come in some measure through deviations from the original general plan.

Many sewers have been built to take care of domestic sewage only, while the storm water was allowed to take care of itself. Later as the cities became more thickly populated and street paving was started, it became undesirable to permit the storm water to follow its natural channel across lots to the nearest water course. As a result many street inlets have been connected to the sanitary sewers. In other cases where storm sewers have been provided with the street improvements a great many roof water drains have been improperly connected to the small sanitary sewers.

The result of such haphazard construction of sewers without a general sewerage plan and very little regard for the future development of the community is that many cities have come to the point where further development of their sewerage is at a standstill. Many other cities are fast approaching such a condition. The present sewers are frequently surcharged and the people connected to them protest against further extensions which will add to the surcharging. Thus we have what we may term "Sick Sewer Systems."

Symptoms of a Sick Sewer System

The principal symptoms of a "sick sewer system" may be briefly classified as follows:

First.—The frequent surcharging of sewers. This condition is due to an insufficient capacity to carry the load connected to the sewer, which may be due to a number of causes. In some cases sewers originally built to handle domestic sewage only have had so many storm water connections made to them that they are overloaded at each light rain. In other cases the original sewers either had insufficient capacity to start with because of improper size or grade, or else the lines have been extended to serve territory not considered when the sewers were originally constructed. The capacity of some sewer lines has become insufficient because of clogging by tree roots or by structural abuse of the tile by careless and irresponsible parties in making house connections.

Second.—Inability to make extensions. The extension may be impracticable and in many cases impossible because of a lack of foresight in the construction of the sewer lines. The lines either were built with too small capacity or at too high elevations to permit of extension into the territory which should logically be served by them.

Third.—Difficult house connections. Very frequently many new houses built along sewer lines are either unable or have difficulty in making connections to the sewer because the sewer is too high or too small. Other houses which are built in areas supposedly sewered, find it necessary to go considerable distances in order to reach a sewer line.

Fourth.—People in new areas do not know what to do for sewerage. Frequently these new areas which have been developed lie at considerable distance from any point where domestic sewage may be disposed of. The expense of an outlet sewer is too great for the people in the new area to finance.

Fifth.—A considerable pollution of streams. The natural drainage of a part or all of some cities is into small water courses. The first sewers were built in the direction of the natural drainage with outlets into the small water courses. At first little or no pollution was noticeable, but as the cities grew the pollution increased until it has become a serious nuisance if not a menace to the public health. In numerous cases successful damage suits have been pressed against cities by property owners downstream because of the pollution of the stream.

Sixth.—Intercepting sewers difficult to build. The existing sewers are very frequently located in the bottom of ravines or valleys with their outlet elevation so low that interception of the sewage is difficult and sometimes impossible without pumping. In other cases there are many outlets which make expensive intercepting sewers necessary.

As the status of an existing sewer system may be judged by the above considerations, conversely, the merits of a comprehensive sewerage plan may be judged in a general way by the extent to which the designer looked into the future and provided against such difficulties.

Remedies

The first step in remedying a sick sewer system should be an extensive and thorough engineering investigation and study of each individual case. All available records and maps of the existing sewers should be collected and, where necessary, supplemented by field work, so that relatively accurate knowledge can be obtained of the location, condition and capacity of the existing sewers.

The object of the engineering investigation of the sick sewer system should be to evolve a comprehensive plan of sewerage which will utilize the present sewers to best advantage, provide relief sewers for critical areas, and which will be adequate for 40 to 50 years in the future.

Typical Problems

The following are a number of typical cases of sick sewer systems which illustrate the conditions which exist in many communities. A brief description is given of the situation and the remedies which were suggested after a thorough investigation of each case.

Streator, Ill.

Streator is located in the North Central part of Illinois, on the Vermilion River. It is a relatively old and well established city, which had a large coal mining industry up to 10 or 15 years ago. Although coal mining is now much restricted, the city has large tile and glass industries and other well established manufacturing interests.

The population, by the 1920 Federal Census was a little less than 15,000, and the estimated population for 1960 was 30,000. Sewer capacities have been recommended for this population.

The drainage of the city is into the Vermilion River, which has a drainage area above Streator of about 952 square miles. Two creeks cut the city into drainage districts.

The first sewers were built in 1880. The first sewerage plan was made up in 1891, at which time a large number of small sewer districts were planned largely without reference to each other or to the earlier sewers. Very few records of actual construction were kept.

Many of the existing sewers are overloaded, and frequent flooding of streets and basements result. Some sewers are large enough for only domestic sewage, while others still give good service for both domestic and surface sewage. Most of the existing sewers are used as combined sewers, notwithstanding the inadequate capacity.

The existing sewers discharge at the most convenient points into the Vermilion River, or the two creeks. A short intercepting sewer has been attempted. There is considerable nuisance along the two creeks. All the sewage eventually reaches the Vermilion River, and at times constitutes almost the entire flow.

The water supply is taken from the river above town. The average consumption is about 200 gal. per capita per day, of which it is estimated 160 gal. per capita reaches the sewers.

The engineering investigation of the situation at Streator indicated that their needs for sewerage are briefly as follows:

(a.) A general plan is needed so that new sewers can be built with the certainty that they will afford satisfactory service. An adequate general plan for sewers is one of the first essentials of a progressive community.

(b.) Some of the existing sewers are too small. New and relief sewers should be built so that adequate sewerage capacity will be available to all parts of the city.

(c.) Nuisances now exist through the discharge of untreated sewage into the creeks and the Vermilion River passing

through the city. The construction of intercepting sewers is necessary to relieve this condition and to discharge the sewage down stream of the city in such a way as to permit of sewage treatment when that becomes necessary.

Portsmouth, Ohio.

Portsmouth is located in the hilly region of the south central portion of Ohio facing on the Ohio River at its junction with the Scioto River. It was incorporated in 1814 and has a frontage of some eight miles along the Ohio River including the small city of New Boston.

The leading industries are the manufacture of shoes, stoves, brick, and knit goods. There are also quite extensive railroad shops, while the City of New Boston has steel mills employing over a thousand.

The population according to the 1920 census was 33,011 but annexation and growth have increased the present population to over 40,000. It is estimated the population will reach from 85,000 to 100,000 in 1970.

The older city of Portsmouth has been provided with sewers for many years. These sewers are so overlapping that it is difficult to describe them briefly.

Both separate and combined systems are in use. However, the major portion of the sewers are intended to be on the separate plan. The larger sewer districts in general are tributary to four pumping stations which come into service at times of flood stage in the Ohio and Scioto Rivers.

The need for improved sewerage is emphasized in Portsmouth by the lack of a general sewer plan. It is difficult to provide for sewer extensions into new areas. Some of the existing sewers are of insufficient capacity, so that new and relief sewers are needed. A considerable sewage is discharged directly into Lawson's Run along the east side of the older part of Portsmouth and into other small creeks causing very objectionable nuisances.

The difficulties with the sewers and especially the nuisances caused by the pollution of the small creeks reached such a bad state that the State Board of Health has ordered the city to remedy the situation.

In Ohio the State Board of Health has police power to order city officials to remedy such conditions and can authorize a bond issue beyond the otherwise legal bonding limits of a city to provide funds for effecting the remedies. Under section 1260 of the Ohio General Code the city officials are subject to a heavy fine if they refuse to obey the ruling of the Board of Health.

The question of sewage treatment required considerable study in connection with the investigation of the sewerage problems at Portsmouth. Up to the present time it has been generally considered that there is a sufficient flow of water in the Ohio River to dispose satisfactorily of the tributary sewage by dilution. However, this problem is being studied at present by the U. S. Public Health Service. It has been generally held, that some form of treatment will be needed before many years and sewerage works at Cincinnati and Louisville for instance have been planned, so that sewage treatment plants can be added when required. On account of its critical location above the water intake, it is necessary to include a treatment plant in the plan for sewerage for Sciotoville, a recently annexed section of Portsmouth where there are no sewers at present.

As a result of an extensive investigation of the sewerage problem at Portsmouth a number of relief sewers were proposed in the older part of the city. New sewers were proposed to serve new areas, and intercepting sewers, were proposed to clean up pollution along small creeks.

All of the projects should be built in the immediate future except perhaps a few small lateral sewer lines. The total estimated cost of the projects is $383,000 of which $101,000 is for a large intercepting sewer in Lawson's Run to remove the pollution and another $132,000 is for the complete system of sewers in the Sciotoville section.

The proposed new construction may be financed in three ways, the sewers for new areas such as the sewers in Sciotoville by assessments for local improvements; the relief sewers by general bond issue; and the removal of pollution from the small creeks, Lawson's Run in particular, by funds from a special bond issue permitted by virtue of the State Board of Health order to clean up the unsanitary conditions now existing. Final decision has not yet been made regarding methods of financing to be used.

Washington Court House, Ohio.

Washington Court House, another of the older Ohio cities originally laid out in 1810, is located in about the middle of

the southwesterly quarter of Ohio. It is about an equal distance from Columbus and from Dayton. Passing through the city are the Baltimore and Ohio; the Detroit, Toledo and Ironton; and the Pennsylvania railroads.

The city is the center of a well developed farming territory. The principal industries include a creamery, two canning factories, a fertilizer works, a creosote company, and a packing company.

The population by the 1920 federal census was 7,962. The future population is estimated at 15,000 in 1970 which figure was used in computing the capacity of sewers for domestic sewage.

At present there are a considerable number of sewers in Washington Court House. These appear to have been developed piecemeal by gradual extension under pressure of individual need for the various districts. Portions of the sewer system appear to have been built in part as land drainage systems, and the drains thus laid have been extended to serve not only as storm sewers, but also to take care of domestic and roof water. No records of design or plans were available. There are at present some 30 different sewer outlets into Paint Creek, a small water way with 65 square miles drainage above Washington Court House. There are almost no manholes along the present sewers.

The lack of a general plan has made sewer extensions difficult. In some portions of the city some of the existing sewers are too small to carry both domestic and surface sewage and as a result basements are frequently flooded.

The discharge of domestic and industrial sewage from the present sewers into Paint Creek passing through the city has resulted in very objectionable odors and nuisances. During periods of dry weather there is very little surface water flowing in the creek.

The problem to be solved at Washington Court House was that of providing a general sewerage plan which will relieve surcharging of present sewers, provide sewerage for areas at present unsewered, and to remove the pollution from Paint Creek.

For comparative consideration, projects were prepared for a combined system of sewers and also for a separate system of sewers including both storm and sanitary sewers. An intercepting sewer was also included which is generally applicable to both systems. The project calling for combined sewers was considered the most desirable for the conditions at Washington Court House.

The main intercepting sewer will be along the east and north side of the creek extending from the northern section of the city to a sewage treatment plant site in the eastern part of the city. A second intercepting sewer will extend along the south side of the creek to a crossing some distance above the treatment plant.

The intercepting sewers were designed to have a capacity of 500 gal. per capita per day at the upper end and 400 gal. per capita per day along the lower sections for the population estimated for 1970. Sanitary sewers were designed for 300 gal. per capita for the estimated population tributary in 1970.

Combined and storm sewers were designed for a capacity based on a rainfall intensity at the rate of 12 divided by the square root of the time of concentration in minutes with a run off of 20 per cent. This intensity of rainfall as judged by records at Cincinnati is not likely to occur more frequently than once in three years and was considered ample for Washington Court House conditions. Storm water overflows are contemplated at points where the intercepting sewer and combined sewers meet.

The treatment plant proposed for ultimate development comprises in addition to the pumping station, an Imhoff tank, sludge beds, sprinkling filters, and secondary settling tanks. The first installation would call for one settling tank of the Imhoff type for a tributary population of 9,000; a sprinkling filter with an area of 0.36 acres; secondary settling tank of the Dortmund or Dorr type and disinfection by liquid chlorine when disinfection is necessary. However, the present sparse population down stream may permit omission of the sprinkling filters and secondary tank for a few years.

The program for present construction includes the construction of the intercepting sewers, the first installment of the sewage treatment plant, and a few main relief sewers and main sewers to provide outlets for areas not at present sewered.

The first item to eliminate the gross pollution of Paint Creek by the construction of intercepting sewers and partial treatment works was estimated to cost from $150,000 to $160,000.

The second step would be the construction of trunk line sewers extending into various sections of the city. The total

including intercepting sewers, partial treatment plant and suggested trunk sewers would be about $195,000.

If complete sewage treatment works are later required the estimated cost of the project outlined above except with complete treatment works was estimated at $243,000. To further extend sewers into districts of the city not now provided with sewerage service would bring the total estimated cost to $431,000.

The cost of sewering the entire city with separate sewers for domestic and storm sewage including new storm sewers on streets now having sewers and including complete treatment works was estimated at $636,600.

Washington Court House has its maximum allowable bonded indebtedness so the financing of the sewerage improvements will have to be taken care of by local improvement assessments and by bonds which can be authorized by the State Board of Health in case of emergency to build the intercepting sewer and treatment works.

Henderson, Ky.

Henderson is located on the Ohio River about 30 miles above the mouth of the Wabash River. It is an old city the original town having been laid out by a Colonel Allen in 1797.

There are a number of substantial industries in Henderson which include several tobacco warehouses, a nicotine plant, a large cotton mill, a catsup factory and several smaller establishments. Adjacent to the city to the east and south are a number of coal mines. The main line of the Louisville and Nashville railroad and a branch line of the Illinois Central pass through the city.

The population in 1920 according to the federal census was 12,169. It was estimated that the population of the city would reach 25,000 by 1960 of which 20,000 will be within the present city limits. This would be equivalent to an average density of ten people per acre.

The city is located on high ground not subject to overflow, and the drainage for the larger portion of the area is away from the river into Canoe Creek, a small waterway which passes along the east side of the city and enters the Ohio River some distance below the city.

Plans for a separate system of sewers were prepared in 1894 by Col. George A. Waring Jr. This system of sewers, however, was not built. A considerable part of the city is provided with sewers, some of which discharge into the Ohio River and others into Canoe Creek. These sewers seem to have been built without any reference to a general plan. The larger sewers were laid in the bed of former drainage ditches and were not placed low enough to drain basements.

The principal needs for improved sewerage were found to be as follows:

a. Relief for many of the present sewers now of insufficient capacity.

b. A general plan for the extension of sewers into areas not now sewered.

c. Elimination of the sewage pollution in Canoe Creek.

As connected up none of the present sewers have sufficient capacity to carry both domestic and storm water sewage; however with proper relief the use of the present sewers as combined sewers can be continued.

Five sewer outlets discharge into Canoe Creek and during dry weather odors and nuisances result. Certain property owners along Canoe Creek below the city file damage suits each year. These suits cannot be successfully defended by the city and have cost the city several thousand dollars annually. The drainage suits are such certain successes that it is claimed locally that certain property owners downstream attempt no other development of their property.

The project recommended to remedy the situation in Henderson was developed to discharge as much sewage as possible by gravity into the Ohio River. The principal features of the project comprise high and low level intercepting sewers along Canoe Creek and a 6 ft. combined sewer cutting through the ridge near the center of the city which will carry the sewage of a large portion of the city to the Ohio River.

Combined sewers were proposed for the area which can be drained into the Ohio because it was found that the most economical outlet for storm water is to the Ohio rather than to Canoe Creek owing to the high elevation of Canoe Creek and the general topography of the city. Separate sewers for domestic and storm sewage were proposed for the area which drains directly to Canoe Creek with capacity, however, in the sanitary sewers for roof water from 67 percent of the houses. The domestic sewage is to be collected to a pumping station and pumped into the upper end of the large sewer extending through the center of the city to the Ohio River.

Storm water sewers were designed for a capacity based on rainfall intensities

equal to 8.5 divided by the square root of the time of concentration in minutes and considering a run-off factor of 20 percent in the outlying areas and 30 to 40 percent in the downtown sections. Rainfall records at Louisville indicate that this rainfall is likely to be exceeded once to twice per year. However, at present and for years past there has been flooding in Henderson at each rainfall without excessive damages. Probable increase in property values hardly warrant a greater protection from storm water than that provided above.

There does not appear at the present time to be any need for treatment of sewage discharged into the Ohio River from Henderson. However, the new sewers proposed were maintained at elevations, so that an interceptor can be built in the future for concentrating the sewage at one point for treatment. The present sewers discharging into the Ohio River will also permit the building of such an interceptor.

The sewers suggested as desirable for near future construction have a total estimated cost, including allowance for financing and engineering and contingencies of $326,000.

The funds for financing the projects of Henderson may be raised by special assessment proceedings which are some what different from those followed in other states. The pertinent section of the law, which may be found in section 3289, Kentucky statutes, reads as follows:

"The common council shall divide said city into districts of not less than three nor more than nine, and as nearly equal in area and population as possible; and not less than one district shall be sewered at one time. The cost of sewering an entire district shall be apportioned among the property owners of said district ratably, according to the superficial area of said property owners' holdings in said sewer district."

Weston, West Virginia.

Weston is located on the West Fork River a branch of the Monongahela River about 30 miles south of Clarksburg, West Virginia. It is the county seat of Lewis County and the center of a community comprising farms, coal mines, and natural gas developments. The industrial development is small.

The population was reported as 5,700 by the 1920 federal census. It is estimated that the future population will reach 18,500 in 1970. This figure was used in estimating sewer capacities.

The drainage area of the West Fork River above Weston, including two small creeks entering at Weston, is 181 square miles. The water supply of Weston and also that for Clarksburg is taken from the West Fork River.

There are a number of existing sewers in Weston. There was no detailed information on record relative to these sewers at the time the investigation was made. A street superintendent who has constructed most of the sewers during the past 30 years carried the only record in his head.

The present sewers are built on the separate system. However many house connections have been made to the storm water sewers. Part of the present sewers empty into West Fork and others empty into each of the two creeks.

At present there is considerable pollution of the streams and there are many areas which have no sewers and have no outlet for sewers without further polluting the waterways.

The remedy suggested for Weston is to build main intercepting sewers along the river and the creek valleys which will carry the sewage to a pumping station and treatment plant just below the city. The treatment plant is to consist of settling tanks and sprinkling filters. The sewers were designed with a capacity of 300 gal. per capita for the estimated future population.

The cost of the entire project including main sewers, pumping station, and treatment plant was estimated at $154,000. Lateral sewers were not included for the reason that it is proposed to raise funds for the main sewers by a general bond issue while all lateral sewers have been built by local assessment. All lateral sewers will be 8 ins. and there will be no question of grade or proper location, as the ground rises rapidly away from the various water courses.

Rhinelander, Wis.

Rhinelander is the county seat of Oneida County, Wis. It is located on the Wisconsin River in the lake district of northern Wisconsin which makes it popular as a summer resort.

The largest industries are some paper mills. There are a number of smaller industries, many of which deal in wood products. The city is served by two railroads, the Chicago and Northwestern and the Soo Line.

The city was organized in 1894 and the population according to the United States census of 1920 was 6,654. It is estimated that there will be a population of 20,000 in 1960.

At present there are a considerable number of sewers of varying size and depth which extend quite generally over the city east of the Wisconsin River. West of the river and the areas in the southeasterly and northeasterly sections of the city there are comparatively few sewers.

The present sewers in most cases are of such size as to be characterized as sanitary or separate sewers. However, many of them have some excess capacity and are being used as combined sewers at present.

There is no condition of active nuisance through sewage disposal at present in Rhinelander. However, there is a need for new and relief sewers to eliminate the surcharging of existing sewers and to provide for the extension of sewers into districts which now have no sewers.

The general problem was to determine on a policy for sewer extension and to develop a general plan according to which new and relief sewers can be built. Provision for future intercepting sewers and sewage treatment was also included.

Except for a small section of the main business district where the present sewers are only large enough for combined sewers, the present sewers are only large enough for sanitary sewage. Also storm water can be carried to water courses or to a swamp area east of the city, with relatively short lengths of drains whereas it will be necessary to carry the domestic sewage long distances. The conditions make it advisable to provide separate sewers for domestic and storm sewage. Accordingly a comprehensive plan for sanitary sewers and another for storm sewers was prepared.

The general plans for sanitary and storm sewers were prepared and then cost estimates were made for tentative projects designated as desirable for present construction.

The additional sanitary sewers for extension into areas not now sewered were estimated to cost $95,800. The cost of the proposed relief sewers to carry storm or surface sewage only, was estimated at $45,000, including a drainage ditch through the swamp along the east side of the city.

Funds for the construction of the new work will probably be provided by a general bond issue which will require a general vote of the people of the city.

The foregoing matter is from a paper before the Iowa Engineering Society.

HOW TO EQUIP AND OPERATE LOCAL GRAVEL PITS TO PRODUCE CONCRETE AGGREGATE

By H. J. Kuelling, Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

This subject may well be approached from one of two angles. First, from the viewpoint of the contractor who is to operate the pit, and, second, from the viewpoint of the engineer or public official who is to pass on the material. What the writer has to say will probably be a mixture of these two.

Many people view the subject of local material with suspicion. This is especially true of contractors who are not desirous of being loaded down with any more equipment or any more troubles. In Wisconsin, however, the contractors are gradually coming to look with favor upon this method of producing material, and there will be an ever increasing competition upon jobs where local material is available.

Economy Governs

In the opinion of the writer, the use or non-use of local material is entirely one of economy; in other words, the question of which is the cheaper, local or shipped in material. It is entirely out of the question for a state, county or local community to subsidize any commercial pit or quarry. The writer frankly admits that commercial pits and quarries can produce cheaper than a temporary local plant and advises using them where the question of freight does not enter and the difference in truck hauls is not too great. However, as soon as freight on a railway enters into the argument, the handicap of ninety cents to a dollar a yard enters, a sum which alone more than covers the average production cost of the Wisconsin local pits.

Local Commercial Production

Instead of the commercial companies sitting back and criticizing, the writer believes there is a good business opportunity for some of them to go into local production with one or more small outfits,

such as will be described below. Plenty of business could soon be worked up for such an enterprising producer, as many contractors with no experience in aggregate production would be only too glad to hitch up with him.

Some people criticize local material on the ground of quality. The good Lord doesn't change the sand and gravel if it is operated locally, rather than commercially. Properly operated, as many local pits are, just as good material is obtained in one case as the other. Assuming proper quality of sand and pebbles in the deposit, sufficient washing and separation of fine and coarse will produce satisfactory aggregates in either case. Improper operation will produce unsatisfactory material, as we all know who have had to reject material.

Local material may consist of the production of fine aggregate alone from a sand pit, the production of coarse aggregate alone from a local quarry, or the production of both fine and coarse aggregate from a gravel pit. The subject confines the writer to the last method, although all three are in operation in Wisconsin.

Wisconsin Production Data

During the past season in that State, there were constructed 355 miles of concrete road. Of these there were 187 miles on which the fine aggregates were shipped on a railway; 84 miles trucked or otherwise hauled directly from commercial plants; and 84 miles produced in local operations. In percentages these run 52.8 per cent shipped; 23.6 per cent trucked from commercial plants, and 23.6 per cent from local production.

In the matter of coarse aggregate there were 153 miles on which they were shipped on railways; 119 miles trucked from commercial plants, and 83 miles produced in local operations. In percentages these are 43.1 per cent shipped; 33.5 per cent trucked from commercial plants, and 23.4 per cent produced locally. Analyzing these on a basis of two coarse to one fine aggregate, it is readily seen that 54 per cent of the tonnage on these 355 miles of paving never saw a railway. Naturally this means cheaper concrete roads, a saving in freight, easing up on the burden of the railways, a saving in bond cost, and an easing up for the contractor in the all-important matter of financing his job.

This is mentioned to show the extreme importance of a thorough study of local materials where they exist. The writer is fully aware that many, in fact, a vast majority of communities, have no such opportunities to save money, but others have and are sometimes passing by a good opportunity, as we did in more than one case.

Locating and Testing Sites

A question of equal importance with the equipping and operating is the locating and proper testing of sites. There is no doubt that much of the ill repute of local production can be traced to lack of knowledge before operations were begun. Then when the pit failed the whole question of local production was condemned.

In Wisconsin we believe the matter of locating the gravel is the duty of a geologist, so all of our material parties are in charge of a geologist, just as they would be if we were to seek a deposit of lead or iron. His knowledge of geology shows him where to seek the best supplies. This has often been brought out in a startling manner in the finding of good pits where the local people insisted no material existed and where the average layman or engineer even would not suspect it. The duty of the engineer, who accompanies the geologist in locating, is to study the deposit from the physical viewpoint of whether or not it can be successfully operated.

Each party is equipped with a Ford ambulance of the type used in the World War. They are also fully equipped with shovels, picks, scales, containers, screens, glacial and soil maps, and any other tools necessary to conduct their work efficiently. Some of the parties carry along small cooking outfits while practically all of them sleep in their cars at night. They are paid a salary and have to maintain themselves out of this. They turn in an expense account for the car, however. Each party is given a number of proposed projects to cover.

The methods of each party vary, of course, with the kind of material for which they are searching. Those parties whose task it is to locate concrete aggregates have to spend more time and take more care in the results than do those parties who are locating surfacing materials.

Locating Aggregate for Concrete

A party locating aggregate for concrete construction must first try to locate a satisfactory deposit as near as possible to the center of the project. If this is impossible they must widen out in their search, always keeping in mind

the disadvantages of long hauls and poor setups. They must also locate in each case the nearest water supply and what it is. They usually do some test pitting, especially on undeveloped deposits, to determine stripping and otherwise prove their conclusions. In general, a field test is made of the material in the nature of a silt, colorimetric and screen test. Their notes are kept on loose leaf forms provided by the Highway Commission. The deposits are spotted by section, town and range, and the owners' names obtained wherever possible. Each deposit is given a location number, these numbers starting at one and running upward consecutively in each county; there being no duplicate numbers in any one county.

Such surveys cost the State in the neighborhood of $40 or $50 per mile of project. After the surveys are made and the field information properly analyzed, it is up to the materials department and the district office to see that the most promising locations are properly test pitted.

Test Pitting

The test pitting is an exceedingly important feature of the work. It must be done extensively and thoroughly. The methods involved and the extensiveness, of course, varies with the kind of material being searched for. If several miles of concrete road are to be built out of a proposed pit, it is necessary very thoroughly to test pit the site, especially if it is an undeveloped deposit. Enough holes should be dug to determine the extent and they should be dug to an adequate depth to determine the working face. We have dug holes 30 ft. and over by using box sheeting of 2-in. boards 4 ft. long dovetailed at the ends. It is an easy matter to construct a windlass operated by hand, and with a hole 4 ft. square a pretty good sized bucket can be attached for raising the material out of the opening. The samples for testing purposes should be taken at the time of digging. Our requirement for such purposes is a representative sample of 500 lbs. of pit run material from the deposit. The samples should not be taken from one hole but from several different holes. Probably the best method of handling the samples is to sack the material in cement sacks. Tags are filled out and one placed inside the sack and one attached after which they are sent express or freight collect to the laboratory at Madison. The man supervising the work also fills out an aggregate sheet furnished by the Commission describing the deposit, which sheet he sends direct to the materials department. Here a duplicate is made and sent to the laboratory and the original kept in the files.

From these samples tests are made, both on the fine aggregate and the coarse. Sand briquettes are made for breakage at three, seven, and ten days. Coarse aggregate is tested in specimens 18 ins. long, 8 ins. in width, and 4.3 ins. in thickness. These are always made at the same time as specimens of standard material. Both are tested at the same time in a rattler and later in tension and compression. By always running these tests with a standard, we not only compare the material with the standard, but with any other.

The information thus obtained is placed in the hands of prospective bidders through the medium of the district offices. The cost of testing material from one deposit is estimated to be about $35. If a prospective bidder is still not satisfied he may make an investigation of all the physical features surrounding its use, such as water supply, topography, soil, roads, etc.

Of course no proposed pit can be guaranteed to be absolutely safe. By this we mean, that even with the best kind of test pitting a few pits, where opened up, disclose objectionable features which were not apparent before. These features may be enumerated as a pit running to sand, too many oversize boulders, and a pit containing heavy seams of clay. These failures, however, are few and often where there has been a failure, some bit of negligence or ignorance was responsible for it.

Effects of Insufficient Test Pitting

For instance, in one case the proposed deposit was thoroughly test pitted, but in setting up the plant it was moved just a little north along the ridge from where the test holes had been. When the ridge was opened they encountered huge boulders and had to change the drag line to a steam shovel. The boulders had not shown up in test pitting and, in fact, the south side of the pit, which was the side nearest the test holes, showed hardly a boulder. Another case was that of a deposit not recommended by the state, but one which the contractor was eager to set up in. Consequently, while a small pit was showing in a ridge it was never thoroughly test pitted. This result was disastrous as the contractor was ordered

to shut down when it was found that the material was running out, and also was becoming too dirty to use for concrete. Another case was that of a perfectly good pit, but wherein inadequate machinery was placed. The contractor placed a small movable outfit in this pit to produce concrete aggregate. The bin capacity was only 18 yds. While the pit run material actually ran 50 per cent sand and 50 per cent stone, the plant was too small to handle the waste sand successfully, with the result that it was an absolute failure and was forced to quit right at the start.

The writer has gone into all this detail of locating and testing gravel pits thoroughly to impress the fact that local production requires considerable gray matter before one should think of the equipment and operation.

Production of Concrete Aggregates

The production of concrete aggregates by means of a local plant is a problem of some magnitude. In the first place, let it be said that a plant for this purpose must be stationary. There is no such thing as an efficient portable plant for producing concrete aggregate. Another adequate bin capacity, for if there happens to be a temporary breakdown in the pit operating machinery and the bins are pretty well filled up, the trucks or other hauling equipment is still able to operate. Of course, the entire equipment must be efficient and efficiently operated as well. Too small a crusher or screens, not enough horsepower, poor management, and a poor pump in case of washing, are some of the objectionable factors in a plant not operating efficiently. The contractor in choosing his set-up and machinery has quite a problem on his hands. He should look the proposed site over well and take all the factors into consideration. He must consider the distance he is to be from the project and also what method of hauling and charging the mixer is to be used. Of course, the problem of set-up does not always rest with the contractor, as there are quite a number of cases where the county has owned and operated a pit, supplying material for its own day labor crew, or else furnishing material to a contractor at a much lower price than he could purchase it from a commercial concern.

Plant Costs

A well built and efficient gravel plant for producing satisfactory aggregates for concrete pavement construction should cost in the neighborhood of $10,000 to $12,000, including the items of erection. The reason for a variance between the above mentioned figures, is the difference in cost between a washing and dry screening plant, freight, erection, etc. A plant of this price has a bin capacity of about 200 yds., which ought to be sufficient. Below is a table showing the approximate cost of a stationary up-to-date gravel plant:

Crusher	$ 2,800
Grizzly screen	50
Blade Feeder	300
Cables, shieves, etc.	300
Hoist	1,000
Drag line bucket	450
Two 60-h.p. motors	2,200
Elevator	500
Screens	400
Lumber for bins, etc.	1,000
Cost of erection	1,000
	$10,000
Cost of washing equipment	700

Another item which is really an extra is the measuring device. Where batch trucks, for instance, are to be used this is an absolute necessity. There have been attempts to construct home-made devices with mediocre success. There are mechanical devices on the market which are quite successful. They are, however, pretty expensive, as an outfit costs about $500.

Description of Good Plant

Two plants of one contractor are identically alike, and while not absolute models of perfection are worthy of description. An arrow-shaped drag line bucket handling about a cubic yard at a time pulls the material up, where it is dumped through a trap onto the blade feeder. This feeder is in the form of an endless belt which has a number of blades fastened thereon. This turns slowly and constantly dumps the material onto the grizzly screen. Thus the material is fed gradually to the crusher while the drag line is making its return trip. The rejected gravel from the grizzly drops into a No. 4 gyratory crusher set at about 1½ ins. Then the material is carried up to the screens in a bucket elevator about 50 ft. high and containing approximately 140 buckets. The screens are of the revolving type, 4 ft. in diameter and in sections. The first section is 6 ft. with a ¼-in. round opening; the second, 4 ft. with ¼-in. round opening, and the third 6 ft. with elliptical opening ¼-in. by 1 in. in size. For dry screening a screen of the last section type is probably the best. However, the last section of screen should have 2-in. round openings to take care of any oversize material. A chute could be built from the end of this screen

back to the crusher. It has also been found very necessary at times to insert a section of ½-in. round screen to waste the pea gravel sizes when the gravel in the deposit runs fine. Two 60 HP motors furnish the power for operating this plant. One takes care of the blade feeder, crusher, elevator and screens, and the other the double drum hoist operating the drag line.

The bins for this plant are 11 ft. wide, 36 ft. long, and 14 ft. deep. They are set on a concrete foundation 38 ft. long with a base of 3 ft. and tapering up to 16 ins. The horizontal timbers resting on this concrete foundation and supporting the uprights are 10-ins. by 12 ins. The uprights themselves are 10-ins. by 10-ins. and 12-ins. by 12-ins. Seven 10-in. by 12-in. timbers are used as braces for the uprights. There are also 14 cross braces 6-ins. by 8-ins. in size, seven on each side; 2-in. by 12-in. pieces are used as floor joists spaced with 6-in. centers. There is also 3x12-in. cross bracing on the side, two being used together making six pairs on each side. The floor and sides of the bins are of 2x12-in. planks, the studding being the same size as the floor joists. They are double rodded, the long rods being 1½ ins. in diameter and the short ones 1⅛ ins. The bin supports or wales through which the rods are bolted are 6x12-ins. doubled. These hold the whole bin together and there are three tiers of them, the first 1 ft. above the sill, the second 4 ft., and the third 10 ft.

Sand Washing

A large proportion of local pits contain enough dirty material to require washing. There is also something in the proposition of expediting the work of the screens by washing, especially on damp days. A number of different types of washers are used. Probably the most common is that of old tilting box type, with which nearly everyone is familiar. The valve control or discharge for the washed sand in this type is dependent of operation upon the weight of the sand contained in the settling tank. There are a few mechanical objections to a washer such as this. First, the inertia of so great a weight makes the valve action slow, so that with uneven feeds the valve does not always close in time to prevent a "runaway". Secondly, a tank of this sort is operated by balanced weights which to operate quickly must be set so that the valve does not close tightly when the feed of sand ceases but while the water is still coming. Sometimes, unless the valve is closed by hand, an amount of water and clay gets into the clean sand already discharged.

There are also steel conical tanks on the market which are quite expensive, but more efficient as the discharge is controlled by volume rather than by weight.

A good many pit operators are using a washer of a different type. This is really a mechanical conveyor sort of settling tank. It consists of a large rectangular wash box of wood, with a discharge for clay and dirty water at one end. The floor of this box slopes upward at the other end to the top. A number of blades are fastened to an endless chain which operates over sprocket gears at either end of the box. These blades dip down into the water, and by close contact with the slanting floor carry the washed sand to the top where it is dumped over into the bins. There is a space at either end of each blade, which permits excess water to return to the tank. These blades continually agitate the dirty water in the tank and keep the dirt in suspension until it is carried off over the spillway. Plenty of clean water must be poured into the tank continually, and it is well to have several sprinklers playing on material as it is pulled up to be dumped into the bins. These washers are sold in two sizes, 4x18-ft., and 3x18-ft., respectively, and are priced at about $500, exclusive of any wash box lumber. The former size has a capacity of 40 tons of sand per hour and the latter 35 tons.

Gravel Washing

Any of these washers, of course, are for sand only. It is sometimes and, in fact, always, just as necessary to cleanse the gravel. For this a water pipe with an end spray can be discharged into the screens. This will aid very materially in pushing the sand through the sand screen into the settling tank, and also for separating the sand from the stone, when it has a tendency to stick together in damp weather. It is also advantageous to have a section of closed screen containing angle irons bolted to the sides, which may be termed a scrubbing chamber. One of the principal requisites for a successful washing plant is plenty of clean water. Four-inch pipe should be used, if possible, and a pump powerful enough and an adequate water supply to produce 250 to 300 gals. a minute, is necessary.

Cost and Production Data

From one pit about 6.53 miles were built. The total job was 7.29 miles in length or 77,176.4 sq. yds. of paving. The low bid on this was $1.07 per sq. yd., exclusive of cement, as against the lowest price bid for commercial material of between $1.12 and $1.16. This is a difference of about 7 cts. per sq. yd., or a total saving of $5,402.35 on the entire job. However, the facts that the pit was easily obtainable and a good set-up, that the hauls were good, and that several contractors were interested who wished to go into their own material production, all had a tendency toward producing one of the lowest bids per square yard in the whole state.

Another job consisted of about 8 miles of 18-ft. paving, the low bid being $1.19 per sq. yd., and the lowest bid per square yard using commercial material was $1.49, or a saving of 30 cts. per sq. yd. This meant a saving of approximately $25,344 on this one job. The plant was equipped with a hoist and upright boiler, arrow scraper, one 60-HP motor, a loader elevator, a bucket elevator, old style washing plant, screens and 160-yd. capacity bins. Provision was made to shoot the rejected oversize stone back into the pit. From this plant approximately 25,400 cu. yds. of sand and gravel were hauled out on the road. This meant an average of about 250 yds. a day on the road and does not include an average of about 20 to 25 yds. of material wasted each day. Material was hauled in trucks onto the road and stock piled every thousand feet. From the stockpiles a fleet of Ford batch trucks carried the aggregate to the mixer.

Another road, 3.3 miles in length, was constructed, the low bid being $1.29 per sq. yd., using local material. The lowest price bid per square yard using commercial material was $1.45, a saving of 16 cts. per sq. yd. This means a saving of $5,575.68 on the entire job. The material was trucked onto the roadbed, stockpiled and wheelbarrows used to charge the mixer. This was the second season that the contractor had operated this pit.

Another job of 4 miles was partly constructed, about 3½ miles being built. The bid per square yard using local material, was $1.11, whereas the lowest bid per yard using commercial material was $1.35, or a saving of 25 cts. a sq. yd. This is a saving of $10,137.60 for the entire job. The material was hauled on the road, stockpiled, and wheelbarrows used to charge the mixer. They had about 6,000 yds. of material stockpiled on the subgrade before the actual paving work started. The equipment at the pit consisted of a bottomless drag line bucket, a plate feeder, a conveyor, a 9x15-in. jaw crusher, grizzly, a 36-ft. bucket elevator, a tilting box type washer, screens and bins, a 60-HP. tractor, a double drum hoist and upright boiler, a 10-20 tractor, and a centrifugal pump. The bin capacity was small, holding only 90 to 100 cu. yds. Provision was made to shoot the oversize stone back to the crusher. The 10-20 tractor furnished power for the pump which had a capacity of 450 gals. a minute, but only about 300 gals. a minute were actually used. The production of this plant was small as it averaged only about 150 cu. yds. of sand and stone to the road per day. The smallness of the crusher was greatly to blame for this as the 9x15-in. jaw crusher was only capable of a capacity of about 10 to 15 cu. yds. an hour. What they should have had in its place was a gyratory crusher No. 3 or 4 in size. The bin capacity was small and the whole plant was not constructed in as stable a manner as possible, probably accounting for the numerous delays and breakdowns. It seems true also from various observations that a scraper of the arrow type will handle a larger amount of material than the bottomless bucket.

One county operated two local plants. One contractor built about 40,634 sq. yds., using material from one of the county pits. His price for this of $1.16 per sq. yd. was based on material at $1 per cu. yd. in trucks at the pit. This material, had he shipped it in, would have cost him $2.18 per cu. yd. for gravel and $1.90 per cu. yd. for sand in trucks at the destination. The comparative hauls were about the same.

The other county pit kept two pavers going, and about 8 miles of road were built using this material. It is rather difficult to get at the saving involved here as the contractor's bid did not include a material price, this being furnished him by the county. The county highway commissioner, however, believes that material was being produced in stockpiles for about 70 cts. a yd. Shipped in sand and stone would have cost $2.03 and $2.20 per yd. respectively, unloaded in stockpiles or bins. As in the neighbor-

hood of 26,000 cu. yds. of sand and stone were used in building the road, it will be seen that considerable saving was involved (at least $30,000) by developing a local pit.

Both of these county plants used wash boxes. Each plant was equipped with a stiff leg derrick and bucket. The material as it came from the screens, was loaded into a large stockpile. From here it was transferred into the big measuring hoppers and loaded into batch trucks.

It will be noted in most of the cases cited above that competitive bids were asked on local and commercial materials. This was done on practically all the early jobs to have figures for comparison. The longer in advance the preliminary information is obtained, the better, providing of course, the locations are properly protected by options so that no individual can corner the supply. The contractor or county which is to operate the pit should determine the output desired, the amount of crushing likely to be required, and the amount of water needed before designing the equipment to be installed.

Advantages to Contractor

While the production of local materials may add somewhat to a contractor's troubles, it also has its redeeming features. He ceases to worry about gondolas, freight trains, train crews, paying for water in sand and gravel, demurrage, and kindred other pleasant things. He has his work more concentrated and can handle his paving crew more efficiently as he knows more accurately the delivery of aggregates than where dependent upon a railway.

In conclusion, the writer fully realizes that the use of local materials is a highly localized matter, but he also believes that where local material exists, the subject is deserving of the very best engineering and contracting talent that can be given it.

With us it has not only been the question of money savings. It has enabled us to do work which could not otherwise be done, as it has relieved the railroads of business which they could not have handled, and left equipment free for those jobs which absolutely had to be handled by rail.

The foregoing paper by Mr. Kuelling was presented at the recent annual meeting of the American Road Builders Association.

THE VALUE OF COMPREHENSIVE WATER SUPPLY INVESTIGATIONS

By Alex Van Praag, Jr., of Holbrook, Warren & Van Praag, Consulting Engineers, Millikin Bldg., Decatur, Ill.

Perhaps no one element is more directly responsible for the uneconomical operation and high maintenance costs, and the ultimate failure and abandonment of municipal water works stations than the failure to conduct a comprehensive and systematic study of the community's water resources prior to the construction of the water works system. By a comprehensive and systematic study of the community's water resources is meant a thorough knowledge of the available sources for a water supply development, together with a reasonable understanding of the possibilities of the chosen source of supply with respect to future extensions and enlargement; and also a complete analysis of the relative costs of developing the available sources of water supply, including operation and maintenance costs. The object of this paper is to discuss the value of such preliminary studies insofar as they apply to shallow ground water sources.

Abandonment of Sources of Supply

That an accusation of this character is based upon sound facts and is just, is evidenced by the substantial number of municipalities which from time to time entirely abandon one source of supply in favor of a newly located source, not infrequently in close proximity to the original or former source of supply.

Influence of Local Conditions

It is manifest, if the above mentioned preliminary studies are to be made, that one of the first and most vital determinations in the study is an assembly of the facts concerning the water bearing strata. Now, throughout certain sections of Illinois the nature of the geological structure is relatively well known and the records thereof are reasonably complete. For example, in most of our northern counties it is reasonably certain that an ample water supply of good quality is readily obtainable if wells are drilled to St. Peter or Potsdam standstone. In such a case a preliminary study requires no extensive prospective or test drillings to determine the local geological structure, but may be considered primarily, if not solely, for the purpose of ascertaining the type and probable cost of any proposed installation.

In other sections of Illinois, however,

the prevailing conditions are decidedly different. In central Illinois, for example, the major number of our public water supplies are derived from shallow ground sources, more generally from water bearing glacial drift deposits. The records of drillings in one community are of little if any value to a neighboring community, and in general the records themselves are very meager. Moreover, the glacial drift is peculiarly irregular and non-homogeneous and there is no certainty in securing any appreciable volume of water until extended drillings and extensive pumping tests have been made. Under these conditions the preliminary studies in connection with a proposed water supply installation are of grave importance, for on their thoroughness not only depends the possibility of the installation from a financial standpoint, but also the feasibility of any installation being made at all. Still further, the reliability and operating success and the cost of maintenance in such cases is entirely dependent upon the action taken as a result of the preliminary investigation.

All too frequently preliminary investigations of ground water supplies are not made at all or they are directed by the unqualified judgment of local persons in preference to being based upon an assembly and study of facts and data best interpreted by engineers experienced in water supply developments. It seems to be the general, mistaken impression of public officials that the first available funds should be expended at once for a part of the necessary equipment for the water works instead of using the first modest expenditure for investigation to insure the water works installation being a permanent and economical one.

Mt. Pulaski, Ill., as an Example

In order to elaborate somewhat on the necessity of preliminary studies and suitable test drillings the author assumes the liberty of referring to, and analyzing, the water supply history of a particular city with which he is personally familiar. It is one which presents a typical case.

Mt. Pulaski, Ill., is a city of 1,510 population. It is built upon the peak of an abrupt hill, one of a few high points in central Illinois. The surrounding territory is quite flat and the nearest well defined watercourse is approximately 3½ miles distant.

The original water works at Mt. Pulaski were installed in 1895 and the source of supply then comprised a single well about 85 ft. in depth, penetrating fine sand, and located at the public square on the very peak of the hill. About 1907, only twelve years later, a new water works station was constructed in the southwest part of the city, the supply then being derived from three dug wells, penetrating a layer of fine yellow sand of more or less indefinite depth. Each well was 33 ft. in depth and was walled with stone. These three wells which are still in service are all located on a single tract of land enclosing about ¾ of an acre. Another similar well but with a 23 ft. tubular extension in its bottom was also located nearby and formerly was held in reserve to meet excessive demands though it later was entirely discarded as a part of the public water supply.

Since their construction these wells have ever been subject to clogging with fine sand, thereby reducing their capacities, causing undue wear on pumping equipment, and resulting in exorbitant maintenance costs. Their yields have accordingly been totally inadequate and the cause of a general restricted use of water. The restricted use of water has resulted in a general tendency to depend upon private wells, all of which circumstances of course, assist in raising the unit operating costs of the public supply.

For some time the city council has realized the necessity of improving the city's water supply resources and during the past year it was prevailed upon by its engineers to conduct a series of test drillings in the hopes of locating a more satisfactory source of supply.

The engineers outlined a systematic program of drilling based upon a study of the surrounding topography, assembled records of previous drillings, and a knowledge of the general geological structure in the vicinity, and the drilling program was instituted.

A series of holes were drilled progressively to the east and south along a more or less meandering line lying just south of the city, where the available data indicated a satisfactory supply was most likely to be located. As each test well was drilled samples of the drillings were collected for examination and accurate logs of the wells were drawn. The logs were platted in section to their true elevation along sections drawn through the principal lines of the drill holes, and an accurate plat was made showing the location of each test hole. This data not only served its purpose during the progress of the drillings but is now a matter of permanent record.

A total of 22 test holes were drilled be-

fore a supply of satisfactory volume was located and the final location determined for a new pumping station. As a result of the drillings, however, the city has located a water bearing strata consisting of coarse sand and clean coarse blue gravel approximately 17.5 ft. in depth and lying between depths of 40 and 57.5 ft. below the surface. The deposit is under a static head of water which rises to within 14 ft. of the surface.

Before concluding the test drillings the city conducted a pumping test on an 8 in. well located at the site of one of the test drillings. The test was conducted under the direction of the engineers assisted by representatives of the Illinois State Water Survey and the State Department of Public Health. It included a continuous pumping of the well for 26 hours, more or less, during which time measurements of the well discharge and of the draw-down both at the well itself and at other nearby points were simultaneously recorded. It should be noted that while the draw-down when first pumping the well was marked and rapid, yet with continued pumping the water level gradually assumed a more or less permanent level and at no time was it lowered to the top of the water bearing strata.

The test data secured indicates that the city can produce from a single well in the vicinity a sufficient supply of water to satisfy its present demand with less than six hours of continuous pumping. Heretofore the present wells have been exhausted after a relatively short period of pumping, and it became necessary to discontinue pumping until they again were replenished, and the supply accordingly has been extremely doubtful at all times.

The total cost to the city for conducting the test drillings approximated $1,500 and the city is now having prepared the necessary plans and specifications for a new pumping station. This new pumping station will probably be constructed during the coming year. It makes the third water pumping station to be constructed in a period of 28 years. It is 16 years since the construction of the present station.

It should not be assumed that the Mt. Pulaski situation is an unusual one and that it did not offer its difficulties all during the period of the drilling. As a matter of fact it was necessary at the outset, in order to satisfy certain members of the city council, to drill two holes on the present pumping station lot. Both of these holes were drilled to more than twice the depth of the present dug wells and each penetrated but a negligible depth of fine yellow sand, water bearing, and thus showed conclusively that the present location is a most unsatisfactory one.

Again, after sinking some 7 or 8 holes with only moderate success the city, against the advice of its engineers, again returned to the present water works site and sunk in the immediate vicinity at least two more holes.

Also during the course of the drilling it was necessary to satisfy the demands of certain council members who have a religious belief in the unfailing "water witch." These particular members, it is interesting to note, were able by the use of the "witch" to trace the water bearing strata from one of the test hole locations, after the test hole had been drilled, for a distance of nearly 150 ft. towards the old pumping station site. At this point they were forced to discontinue the use of the "witch" because of severe cold weather and unfortunately the weather has not as yet sufficiently moderated to permit their again bringing out the "witch" for further service.

Now it should be noted also that at Mt. Pulaski there were no visible or outstanding assurances of success in locating a satisfactory water supply if the test holes were sunk excepting the convictions of the engineers who had devoted some time and study to the local situation. To be sure, many of the first holes sunk indicated discouraging results and it was not until the entire 22 holes were sunk that conditions were considered satisfactory to warrant discontinuing further investigations. On the other hand in a similar study at Witt, Illinois, it was found necessary to sink but 5 holes when sufficient data was secured to warrant discontinuing drilling.

Now it is not of general interest that Mt. Pulaski has experienced particular success in improving its water supply by drilling. The Mt. Pulaski experience is discussed herein because it embraces a typical experience and illustrates the one point the author wished to impress, and that is this, by a modest expenditure for test drillings and preliminary investigations and by truly studying and investigating its water supply resources this city has located a source of water supply sufficient to warrant the abandonment of its present supply in favor of a new one. This new supply was only recently investigated, but had it been properly investigated before the preceding two water pumping stations were installed it would doubtless have made unnecessary the very large expenditure for rebuilding at least

twice, and also it would have eliminated very largely the relatively exorbitant maintenance costs which have been experienced by the city for the past 28 years. Many other cities have had much the same history as Mt. Pulaski; and not until the value of thorough preliminary studies is fully appreciated can we expect to eliminate this needless waste of money on water work improvements.

As engineers or persons otherwise interested in the proper development of public water supplies it remains with us to exert every effort to make sure that future water supply installations will be made based upon sound facts and not upon chance judgment. In other words, if we wish to insure proper and economical water supply installations, and assist in preventing expensive rebuilding programs, we must impress the responsible officials with the necessity of comprehensive and systematic preliminary water supply investigations directed by competent engineers. By such means only can we prevent the continued recurrence of experiences such as those of Mt. Pulaski.

The foregoing paper was presented at the recent annual meeting of the Illinois Section of the American Water Works Association.

MAINTENANCE OF MACADAM ROADS WITH BITUMINOUS MATERIALS

By H. S. Perry, Assistant Chief Engineer of Maintenance, Ohio Department of Highways, Columbus, Ohio.

The maintenance of macadam roads is about the biggest problem in road maintenance in Ohio as well as in many of the eastern states. At the end of 1921 there were 1,153 miles of waterbound macadam and 624 miles of penetration macadam under state supervision in Ohio, representing 47 percent of the State improved mileage. On the surface only of this mileage there was spent a total of $2,393,500, representing 40.5 percent of the expenditures of the Bureau of Maintenance for that year. The surface maintenance of waterbound macadam represents about $1,600,000 of this, or $1,375 per mile of surface, the average width for the entire State being about 15 ft.; bituminous macadam maintenance represents about $800,000 of this, or $1,285 per mile of surface averaging 16 ft. in width. It is necessary to qualify the above figures with the remark that the waterbound figures include 95 miles of resurfacing at a cost of about $800,000 and that the bituminous macadam figure includes 40 miles of resurfacing at a cost of about $475,000. The plain maintenance figures therefore for 1921 were about $760 per mile for waterbound and about $590 per mile for bituminous macadam.

Surface Patching

There is no end to the manner and method of repairing the surface of a macadam road, the variations in manner ranging from the experimental to the expert, and in method depending on the materials used.

(a) The paint patch will be first discussed. The original purpose of the paint patch was to cover up a barren spot on the surface where the surface treatment had worn off. We have broadened this in Ohio to a point where quite a heavy patch can be made by painting. In making a skin paint patch it is desirable to use a fairly light bituminous material—such as medium tar (with a viscosity of about 30). Tar or asphalt cut back make satisfactory light paint patches—better in fact than medium tar, but are much more expensive. We are following the State of Pennsylvania in developing a cold asphalt by fluxing back a hot asphalt with naphtha, principally for surface treatments; but it will in all probability be a satisfactory material to use in paint patching. It is not out of place here to emphasize the extreme desirability of not using too great a number of bituminous materials in maintenance work. As a class the labor units do not make a very great pretense at brain work and therefore are likely to become confused with too much to remember. Local conditions should always be used as a guide in determining the number of different kinds of bituminous materials. If there is but a small volume of work, tar or asphalt cut back, which can be used for practically all kinds of surface patching, should be purchased, perhaps to the exclusion of any other material.

Skin Paint Patch

In preparing the surface for a skin paint patch, it is only necessary that the surface be clean and quite dry, inasmuch as this work presupposes a previous surface treatment. During the major portion of the working season the materials mentioned above are sufficiently fluid to omit heating. Heating, however, is of value, especially with the cut backs, and with all materials in cool weather, in that it assists in drying the surface and assists the laborers in a more uniform applica-

tion and increases adhesion with covering. The surface should be covered liberally with the bituminous material used, at least in a quantity that will equal or slightly exceed the amount of bituminous materials on the adjacent surface. For a covering in this case considerable latitude obtains. It is not necessary that the covering be dry, although a better job will result, if dry. Gravel, crushed or round, slag, limestone, igneous rocks, crushed and of good quality, and of size one-tenth inch to three-quarter inch, depending on availability, may be used. An ample supply should be used, since traffic will whip off a considerable amount. If it is apparent that a rainfall is imminent, work of this nature might well be delayed; it is highly desirable that one day's dry weather follow it up, to expedite setting. This kind of patching gives variable results, depending on dryness, cleanness, traffic, subsequent weather, etc., and should be followed up with subsequent bituminous protection.

Heavy Paint Patch

The heavy paint patch has grown considerably in my favor during the past two years and in my opinion bids fair to entirely supplant any kind of thin cold mix patching. In the construction of this heavy paint patch but one bituminous material is being used. This is hot tar, a heavy tar requiring heating at all times, and approaching penetration tar in its float test requirements. This patch is to be used to remove depressional areas, chatter bump dips, and to build up slightly low edges. Also in the prevention of slipperiness on treated macadam surfaces I know of no better method than the use of the hot tar paint patch. In my opinion it is necessary to carry on this latter method by hand, since only in this way can an ample supply of screenings be incorporated into the surface. If a distributor operation is attempted, there will be too great a cooling of the bituminous material and too complete a covering of the screenings with tar, thus destroying the mosaic surface that would otherwise be produced by hand. The same principles apply in the construction of this as with the skin paint patch. As a covering a hard crushed material is necessary, of a size one-quarter to one inch, varying the size of the material with the requirements. As a preventive of slipperiness on grades, a covering approaching the upper limits would probably be preferable. Volume of traffic would also be an influencing factor here as elsewhere, the greater volume warranting a coarser material. It is my opinion that, generally speaking, for maintenance as well as for construction, the tendency has been to use entirely too small sized stone.

The same things hold true in the use of bituminous materials in surface maintenance. The general tendency seems to be toward the substitution of a heavier material for a lighter material of the same base for a particular grade of work. This is especially true where such change would tend to reduce the number of bituminous materials used. During the past two years the Ohio specifications have dropped 3, and now carry 16, of which 7 are asphalt and 9 tar.

Cold Mix Patch

(b) Next comes the subject of the cold mix patch. This includes asphalt emulsion, rock asphalt, and cut back (tar or asphalt). We have not seen fit to develop the use of asphalt emulsion, due to price and to the fact that it is injured by freezing, due to its water content. It has other minor objections, but is a highly satisfactory material. The use of rock asphalt as a cold patch material in Ohio has shown that it is a remarkable material. It is excellent in pot holes and in the repaving of sections of sheet asphalt and asphaltic concrete, in that the sole equipment required is a roller, together with minor tools, of course. This material relieves one of the necessity of using a hot mix plant for sheet maintenance and in this respect is very satisfactory. A compaction of one-third must be allowed for.

Cut Back Patch

The cut back patch has been developed very extensively in Ohio, both asphalt and tar being used. It is adapted to wide usage; and its abuse is about in proportion. There are several variable conditions that determine whether or not this patch is to be successful. The quality of the bituminous material, the moisture content of the aggregate, the quality, shape, and sizing of the aggregate, the proportion of the mix, the care in placing, and the subsequent attention to prevent raveling, are the chief elements. We have gradually varied the quality of both asphalt and tar cut back, so that we now have fairly satisfactory materials. I believe, however, that a further increase in the viscosity of tar, say ten points to 50-70, would improve it. A very great source of trouble arises in the second element: moisture content of the aggregate. I have frequently observed the curing mix covered with tarpaulins and

the untreated left unprotected; not that it is all advised to protect the curing mix; it is much more important, however, that the untreated aggregate be kept dry. We have during the past two years constructed a number of mixing sheds. These sheds are primarily designed for the purpose of guaranteeing a dry aggregate. They also provide quarters in which to carry on this work in inclement weather and are giving excellent satisfaction.

Good cut back patching cannot be secured unless the aggregate is absolutely dry. The quality and sizing of the aggregate are of importance. Inasmuch as the resultant product is worth $8 to $10 per ton, this fact alone should warrant the use of a hard and tough aggregate. None but a crushed material should be used, since rounded material tends to induce waving. We have found it desirable to use two sizes: three-quarters to one-quarter, and one-half to one-tenth. In a great many cases a mixture of these sizes, about two-thirds of the coarser and one-third of the finer, have proved very satisfactory. Occasionally a coarser aggregate has been used; but generally when this is the case a penetration patch is to be preferred. The aggregate should be free from dust, since dust prevents the proper coating of the aggregate. Some authorities use sand as a part of the aggregate; but sand seems to have the same objections as dust; besides its use brings in another variable factor, and its use is not necessary to secure density. (Traffic will take care of this item.)

The proportions of the mix deserve special consideration. Too frequently the laborer will hazard a guess as to "how much is a shovelful?" It is very important to know exactly how much of aggregate and how much of bituminous material is used. If the hand mixing method is used, a bucket should be the unit, and not a shovelful. If a mixing machine is used, let a line be marked on the skip at a point determined by a definite number of bucketfuls, and let this line be carefully observed. If mixed by hand, the aggregate should be spread out on a platform ample in width for two men to work opposite, and the bituminous material spread over the aggregate. This should be turned seven or eight times, at least, until all the aggregate is coated. Neither the earth nor the surface of the road should be used as a mixing platform; the earth being a wasteful place, and the surface of the road dangerous. If mixed by machine, the drum should not be over two-thirds full when running, and the batch should be mixed three minutes. The mixer should be cleaned with kerosene daily when in use.

The proportions vary with the method, more bituminous material being required by hand than by machine, and more being required when a poorly graded aggregate is used than when a well-graded aggregate is used. An excess of fines requires more bituminous material, as does also a porous aggregate, especially slag, which should not be used in cut back, if it is possible to avoid it. In general a well-graded aggregate mixed by hand should require by volume one part tar or asphalt cut back to twelve parts aggregate; by machine add one-half to one part aggregate. If slag is used it is almost imperative that the mixing be done twice, using 1 to 12 or 13 during the first mixing; and after an interval of one or two days, permitting the absorption of the bituminous materials, remix, using about one-third more bituminous material. Let it be remembered that a successful mix requires bone-dry aggregate. The care in placing the cut back is an item that deserves its consideration from the standpoint of aesthetics as well as durability. Those placing the cut back should carefully follow the depression, remembering to lay the patch slightly high, carefully raking and smoothing the surface with a shovel (square pointed) and tamping the surface uniformly with a steel 8x8-in. tamper. Remember that it is easier to build up a low patch than to chop off a high patch, and do not worry about whether the first patch placed is going to iron out just right under traffic. In tamping do not cover the patch with clean stone to prevent sticking to the tamper. A little kerosene on the tamper on occasion will take care of this annoyance. Before placing the cut back the surface of the road to be patched must be painted. Let the painting extend in annular rings, 6 to 8 ins. around the entire cut back area.

The most desirable material to use is heated hot tar or heated cut back. Be careful in heating cut back, as it is quite inflammable. Use nothing less than a 2-barrel (110-gal.) kettle. so that the entire contents of one barrel can be deposited in it at one time. This painting will require about one-third to four-tenths gallon per square yard. Be careful to prevent the formation of pools in low spots in the surface. After the completion of the cut back patch, cover the marginal 6 to 8-in.

space with untreated ¾ to ¼-in. stone. This will serve the double purpose of easing off the patch and protecting the edge. Under no circumstances should it be omitted. In case the cut back patch reaches to the edge of the metal, the further precaution should be taken to keep the edge true to line. It is good economy to use two by fours flat as marginal forms. The cut back along the edge must be carefully tamped vertically before the forms are removed and at an angle of 45 deg. immediately after their removal. Let this tamping be done carefully, as the initial failure of an edge patch usually takes place at the edge and can be prevented by careful attention.

And last in the care of a cut back patch comes the question of subsequent attention. Regardless of careless proportioning and moist stone, careful maintenance can keep a patch of this kind from raveling. It must not be neglected, whether traffic be heavy or light. Heavy traffic will iron the patch down, but it will also cause it to ravel. Light traffic will not iron it sufficiently to prevent its weathering. Immediately on the first evidence of raveling, the patch must be painted, using a fairly heavy material. Medium tar will not prove satisfactory, as it is absorbed too readily, and the quantity required would be so excessive as to soften the patch. Use either hot tar or cut back, either sufficiently heated to be spread readily in a uniform coating.

As an evidence of the virtue of this subsequent maintenance, I would like to observe that our Eastern Division on 50 miles of the National Road, consisting principally of brick, has done a great amount of cut back patching during the past year and to my knowledge has not lost one patch. Cut back patching on brick is most difficult, and success in this case I attribute largely to painting the patch on initial raveling. I am quite willing to state as my conviction that if the above considerations are all carefully followed there will be very few failures in the use of the cut back patch.

Penetration Patch

(c) The use of the penetration patch is more or less limited. Some say that they can make this patch stick; and that they therefore use it always. This should not be the case. As a general rule there should be no trouble making the penetration patch stick. Its chief objection consists in getting a rough job, because a thin patch can hardly be made in this manner. This patch should be used only where the place to be patched is about 3 or 4 ins. deep. Stone 1½ to 2½ ins. in size should be used and the patch made after the manner of a construction job.

Penetration tar or asphalt should be used and in the proportion of about 1 gal. per sq. yd. per in. depth. Preceding the application of the bituminous material the stone should be rolled with a 10-ton roller, taking care that on a large patch the proper cross sections be secured by the proper addition or removal of stone and re-rolling. Let the screenings be clean (¾ to ¼-in.) and spread by longitudinal casting and not transverse. This latter method of casting from the edge over toward the center is very likely to leave ridges in the patch that no amount of rolling can eliminate. In case the patch is small, it is best to see that it is built just a trifle low and later built up by cut back or paint patching or both. A penetration patch should never be attempted without the use of a road roller, whereas a cut back patch does not require a roller unless traffic be light, or the patch very extensive, and in this case the use of the roller is justified for the sake of speed. If the penetration work is not very extensive, the use of tar would likely be preferable, due to the fact that it requires less heating. If the volume of this work is large, requiring tank car usage, either tar or asphalt might be used, depending on the price applied.

Repairing Breaks in Waterbound Road

(d) We have had frequent breaks clear through the surface of a waterbound road, with no roller to use in their repair. The customary method followed with excellent results has been to dig out the failed portions and tamp in coarse stone in layers by hand until the hole is brought up about flush, filling with fine screenings dry tamped. Then the surface is amply covered with screenings kept in position daily under traffic for a week or two, depending on traffic, until pretty well compacted. It is then cleaned thoroughly, painted and brought up with cut back and paint patching several times until there is no more settlement. The secret of success in a patch of this or any other kind consists in getting results that traffic will not shy away from, the answer being that one must secure a uniform easy riding patch of the same color and appearance as the rest of the surface.

I might note that our waterbound surfaces are all maintained by bituminous treatments and that traffic naturally shies from one of these traffic bound spots be-

fore it is surface patched. The result is that during the first day after it is surface patched it goes down very decidedly, due to the fact that traffic is no longer afraid of it. I mention this as a trifling incident; it is, however, an illustration of one of the requirements of good patching taking into consideration the psychological effect of the appearance of a patch on the automobile driver. Many a driver will shy from an unsightly patch just as he would from a hole, even though the patch be substantial. The first lesson for a laborer to learn in making a patch is neatness; the second, accurate observation of his and others' previous work. Experience is of course the teacher, but one possessing these two qualifications is almost sure to develop into a good man.

Surface Treatments

The purpose of a surface treatment should be two-fold: It should waterproof the surface and it should offset surface abrasion. In some quarters it is the belief that the treatment should be merely a waterproofing of the surface, and consequently an annual treatment of a light-bodied material is applied. There can be no question, it seems to me, but that this only partly takes care of the problem of macadam maintenance. I believe, however, that the formation of a thick protective mat should be discouraged, as this mat will very frequently lead to excessive maintenance costs in itself. The correct thickness of a surface mat should be determined by the texture of the surface and should be only such as will just cover the projecting tops of the surface stone. In what follows, a brief attempt will be made to outline present practice in Ohio, where I think the surface treatment has been developed in a very satisfactory manner.

General

A surface treatment consists in the application of about one-fifth to two-thirds of a gallon of tar or asphalt per square yard. This application is made either hot or cold, depending on the quality of the material and the season of the year; it also varies in kind and quality, depending on the requirements of the surface. Whether to use tar or to use asphalt in surface treatments has been a mooted question. This perhaps applies also to a choice between these materials in other maintenance work. An inexperienced or personally interested party can certainly mess up the work by arbitrarily deciding that such and such materials shall be used without regard to requirements or possible effects. It is a criminal shame that political expediency, inexperience, or personal interest should have the least say in this and allied maintenance and construction problems.

When it comes to a choice between tar and asphalt for surface treatments, the initial cost is but one of the items of consideration, and it is usually of minor importance. In general tar has the advantage of being suited to wider usage; whereas asphalt has longer life. Tar generally costs more than asphalt, but requires less covering and less subsequent watching; the initial cost of the treatment is by no means to be determined by the cost of the bituminous materials. Asphalt should not generally be applied so heavily as tar. In this respect its cost is reduced relatively, in spite of its large covering requirement. Tar can generally be placed on any surface; whereas asphalt usually requires a rough, previously treated surface. We have developed light, medium, and heavy bodied materials to take care of the various surface conditions. Cold asphalt and cold tar are the light materials, medium tar the medium, and hot tar and hot asphalt the heavy bodied materials. Heretofore, we have used practically nothing but cold tar as the light material. As noted before, however, we are developing a cold asphalt as a naphtha cut back from hot asphalt and expect to try it our during 1923. At the same time we have been using a light material of hot asphalt generally, rather than tar, as the heavy bodied material. In general a new waterbound road should have a penetrating treatment of light bituminous materials: a waterbound retreatment or bituminous macadam original treatment should generally require medium; a rough, well-voided, large-stoned previously treated surface might generally take a light treatment of heavy bodied material. Hot asphalt requires such an excess of screening and so careful watching that even the location of the proposed treatment should be given consideration. If traffic is heavy and the shipping point for covering remote and haul conditions bad, it should not be used, even if the surface conditions might warrant its use.

New Waterbound

We will now discuss in some detail the quantities and kinds of bituminous materials to use on the different macadam types. A new waterbound road should be given very careful cleaning before its first treatment. Its subsequent surface

maintenance depends very largely on its initial treatment. This type should be traveled considerably, if possible, before treatment, even if the surface starts to ravel. The treatment should not be applied after the fall rains start in, or at any time when the surface is not entirely dry to a depth of 3 or 4 ins. It should be very thoroughly swept with a rotary broom in good condition, entirely removing all surface dust and exposing the stone down as far as possible, even if some raveling occurs. If the edges or any other portion of the surface require the use of a light grader, or handwork, to remove a mat of dust or screenings, let same be used. The surface should be completely cleaned before treatment. As stated before our present material is cold tar and it is extremely satisfactory. It is sometimes combined with medium tar, where the length of the section is sufficient to warrant the shipping of each in tank car quantities. If nothing but cold tar is used, the first treatment consists of about one-third of a gallon per square yard. If the weather is quite warm, this material will be absorbed without covering, in one or two days. This will penetrate one-half inch or more and gives a surface the appearance of a penetration road. This application we then follow up with about ¼ gal. cold tar or 1/5 gal. medium tar, depending only on tank car grouping. These two materials are very similar, the higher limit of viscosity for cold tar approaching closely the lower limit for medium tar. As a covering for this treatment ¾ to ¼ in. crushed stone or slag, or ½ to 1/10 in. gravel is used; the quantity per mile of 16 ft. pavement varies because of the weight of the various materials, but runs approximately for this, 60 gal. treatment 100 tons for stone, 80 for slag, and 110 for gravel. If the cold tar can be absorbed without covering, as is often possible, deduct 20 tons from each of these figures. For this treatment it is not at all serious to have too small an amount of covering on hand, provided the supply is spread uniformly. At the same time it is preferable that an excess amount be on hand. It is also generally desirable that one side of a road be treated at a time, for the sake of traffic; but this treatment dries out so quickly that little inconvenience is experienced. It may be desirable to treat hilly country with cold tar or possibly cold asphalt always, so as to preserve roughness, without covering, or with but a very limited amount of covering.

Retreatments

A waterbound macadam retreatment should follow an original treatment the succeeding season; successive retreatments can usually follow every second or third season. There is generally very little difference between a waterbound retreatment and an original or retreatment on a bituminous macadam surface as to kind and quantity. It is usually satisfactory to apply about 0.30 gal. medium tar and, where conditions warrant, about 0.25 gal. hot asphalt. We have tried as low as 0.20 gal. medium tar, but the mat secured was found so thin as to do very little good and consequently required treatment the following year. It is my opinion that although the inconvenience does not last a great length of time, we owe it to traffic to avoid annual retreatments if it is possible to do so.

If the retreatment is tar, covering as specified for the original treatment may be used in quantity about two-thirds. If it is desired to produce a rough surface, due to hills, or special traffic requirements, such as a preponderance of horse-drawn vehicles, or heavy automobile traffic, a coarser covering should be specified, and of a hard crushed material. The use of a heavy roller is here necessary, in order to force the covering into the surface and crush the coarser element. In producing a rough surface it is necessary to avoid the use of asphalt, as this material naturally requires a great excess of covering and absorbs it, with the result that a uniform mat is produced that soon presents a fairly smooth surface. When hot asphalt is applied, the use of a roller should be dispensed with. The 0.25 gal. treatment absorbs as much covering as the 0.60 gal tar specified above, and it must be so completely covered in order to prevent its picking up that traffic is very little inconvenienced. Besides the use of the roller is very likely to cause picking up, due to its own weight and the freshness of the asphalt. It is true that traffic will kick off some of the covering, but this only goes to the edge of the road, and since this particular treatment needs close watching, there is thus provided along the edges an amount of covering that can readily be swept back into the surface in case of bleeding.

With this treatment it is imperative that surplus stock piles be distributed along the road at convenient places. For once picking up starts, it is almost impossible to prevent disaster unless the supply is at hand. Unlike tar, a hot asphalt picked up spot will not heal itself but

must be patched. If this treatment does start to pick up and no stock piles are on hand, a light application of dust from the shoulder upon the bleeding up spot may suffice to prevent further trouble. But in the preparation of a section for a hot asphalt treatment, the first care should be to stock along the road the surplus, and then distribute the covering. Do not repeat hot asphalt. Follow with a cold or medium treatment once or twice. Then use hot asphalt again, if desirable. This should tend to discourage waving. Hot asphalt should not follow itself after less than a four-year interval.

In Ohio we operate ten complete surface treating units. These consist of pressure distributor, camp truck, supply truck, rotary sweeper. Six men complete the personnel, not including, of course, the labor required for spreading covering material. Each of these outfits treated an average of 90 miles during 1922, showing that for the state as a whole, biennial treatments are required. The distributors range in capacity from 1,000 gals. to 600 gals., the lighter proving satisfactory in hilly country with scattered work. The camp truck is a 1922 innovation and has proved itself highly efficient. It houses all the men and is equipped for cooking purposes. These outfits were built up by crews themselves during the winter previous. Later on it is proposed to add to each unit a power covering spreader. Up to date there is nothing on the market that has proved satisfactory, in our estimation. Several horse-drawn spreaders are on the market, but it is our notion that the covering should be spread ahead of any part of the spreading unit, in order to secure good results. Spreading by hand is expensive and one can well afford to consider means of getting away from it, if possible. It is quite difficult to get covering spread uniformly by hand. However, when cast by shovel carefully good results can be secured, provided the laborer casts sideways and does not throw the covering in a pile and then attempt to spread it out with his shovel. I believe that well-designed mechanical spreader will reduce the cost of covering 1 ct. per sq. yd; or on a basis of cost of $8,000, and considering past volume of work, such a piece of equipment would pay for itself in one season. Our costs of treatments during 1922 were approximately as follows: Original 0.60 gal. waterbound, 12¼c per sq. yd.; 0.30 medium treatment, 7½c; 0.25 heavy treatment, 7¼c. The length of life is: Original one year; medium, two to three years; heavy, three years.

Resurfacing

It is my intention to discuss this subject in but a limited way. It is a very necessary part of the subject in hand from the standpoint of limiting expenditures on any existing surface. Varying with the volume of traffic, there is a certain limit beyond which we are not justified in carrying on our ordinary maintenance. This figure we have generally arbitrarily set as about $1,000 per mile (exclusive of the surface treatments) on light traveled and $2,000 to $3,000 per mile on heavily traveled sections. The construction item interest on investment has a certain bearing on the matter; but the requirements of traffic generally provide the deciding factor. It is sometimes advisable to resurface certain sections that might otherwise be held over a year, in connection with adjacent work, thus forcing traffic to detour but once for both jobs. In a little more than half of our macadam resurfacing mileage, a macadam type is used; in the remainder a more expensive is used, depending on costs, local conditions, and adjacent types. We will discuss madacam maintenance by widening, the use of penetration tar or asphalt, the extensive use of the cold or hot mix patch.

(*a*) *Widening*

It is the general failing of a macadam road to increase in crown under traffic, due to both lateral and vertical yielding. Where this has progressed to a point where ordinary edge patching is not economical and a complete resurfacing is not necessary, it can be very well taken care of by feather-edged widening, because it is generally true that failure of this kind is due to insufficient width. In doing work of this kind it is customary with us to consider the results secured as base course work, even though resurfacing be not contemplated as a part of the operation, and secure a width 2 ft. in excess of the ultimate resurfacing width, thus providing a sub-shoulder that will tend to reduce lateral yielding under traffic. The edge of the old pavement is not disturbed by the widening, which is generally excavated to a depth several inches below the base of the old metal and filled and rolled waterbound flush with the top of the existing surface. Then an additional course is added sufficiently thick at the edge to feather over toward the center so as to produce a uniform crown of 3 ins. in 9 ft. But one size of stone is used, even though the feather edge be quite thin. It is necessary that the quality of the stone be good, in order to reduce the crushing to a minimum. The same operation is re-

peated on the opposite side. The difficult job consists in preventing raveling toward the center. This is accomplished by the use of the bituminous patch. Inasmuch as this kind of work can usually be done under traffic, it is quite necessary to follow up closely with this patching. Usually the cut back patch can be feathered out where the depth is not too great; on the deep spots the use of the penetration patch is to be preferred; all this patching to be perfected by the use of the roller. Careful patching will result in a very uniform crown. Immediately on completion and drying out this feather-edge widening should receive a careful brooming and a light bodied treatment sufficient in quantity (say 0.40 gal per sq. yd.) followed up by a treatment of the entire surface, so as to seal up the patching and produce a uniform-appearing surface, so that traffic will not feel inclined to be skeptical as to what portion of the surface should be used. We had a sample of the above work on a section of the National Road during 1922. This was widened to 20 ft. and feather-edged, with the expectation of resurfacing 18 ft. bituminous penetration. The results secured were so very satisfactory that the top was omitted and the surface has every appearance of an entirely new job, and is undoubtedly good for several years, permitting the use of the additional money in other work.

(*b*) *Use of Tar or Asphalt*

The preferential use of tar or asphalt in penetration work might receive brief attention. Generally, in minor patching, with the use of a heating kettle, tar is to be preferred, due to its lower melting point. On extensive patching or resurfacing, several elements deserve consideration, such as size and quality of stone, season of year, relative costs. It frequently happens in a late seasonal application that the bituminous materials are insufficently heated, due to natural causes.

Asphalt is more likely to be underheated in this case and therefore not give the desired penetration. Moreover, since it has a high melting point, it never gets very fluid and is not likely to flow into the lower voids. During mid-season, on the other hand, this property acts to the advantage of asphalt, because an asphalt penetration road bleeds very little or none at all during the summer. The size of stone has considerable to do with the desirability of using either one or the other material.

I should like to digress for a moment. It is my opinion that there has been too general a usage of small stone in penetration work. After earnest solicitation, the Ohio Department of Highways specifications for 1923 were altered, requiring number one aggregate for this purpose, previously having specified number two. The size is now 3½ to 2½ ins., number two being 2½ to 1½. The only argument I can see in the use of smaller stone is that of getting a smoother top with the finer stone. On the other hand, the rougher surface secured with the coarser stone gives a much better bond with the surface treatments later applied, and assists us in keeping away from one big disadvantage of this type, namely, extreme slipperiness in cold weather. When the stone is fine and the voids small, tar is likely to penetrate farther than asphalt. When the stone is coarse, asphalt is to be preferred. If it is determined to construct a penetration road and soft stone must be used, it should be absolutely free from small sized material. Whereas, hard stone should be thoroughly keyed before the bituminous material is applied, soft stone should receive by far the major portion of its rolling after the application, and a greater quantity of bituminous material should be applied. When hard stone is used it is possible to get along with as little as 0.8 gal. of tar or 0.75 gal asphalt per sq. yd. per inch depth of finished road. In case the filler sinks below the top, as is quite probable in this case if tar is used, excessive rolling must be done to bring it back to the surface. Many a hard stone penetration top has raveled badly, due to lack of rolling. Any contractor who realized the difference would seldom take a cheaper soft stone, if he could get a more expensive hard stone that would stand considerable rolling, especially if he is being paid unit prices on bituminous materials. If soft stone is used asphalt is to be preferred, as it will stand nearer the surface after application.

(*c*) *Extensive Use of Rock Asphalt*

And now for a few final words regarding the extensive use of the cold or hot mix patch. There is a little theoretical difference between a small job and a large. However, on large work of this kind, amounting to resurfacing, the commercial introduction of Rock Asphalt has shown it to be a material of very high merit. Sections in service in some places receive a very considerable volume of traffic, much of which is heavy, and at an extremely low surface maintenance cost. Others, due to improper construction, have high maintenance costs. We have resurfaced

in large patches existing hot mix surfaces that had become extremely wavy. The material is very well adapted, requiring but rakes and a roller. In a short time it is difficult to tell this material from the rest of the road. When an error is made in the use of this material, it usually occurs in connection with macadam base construction, either in making the base too thin or too narrow. The base should be made ample in thickness, just as though it were to be the finished road. It should be made at least a foot and a half wider on each side, both to resist lateral yielding and to avoid the necessity of laying this asphalt on the screening mat that usually lays on the outer edge of a waterbound macadam road. A large hard stone should be the macadam aggregate, well keyed, well built, and well voided on the surface. The asphalt if carefully raked and carefully edge-tamped and not over-rolled will prove very satisfactory. Rolling should be done during the heat of the day, once over, and repeated the first and second day following. Any amount can be built before rolling, provided traffic be kept off.

The foregoing matter is from a paper presented at the recent Road School at Purdue University.

CONDENSED MANUAL OF SEWAGE WORKS OPERATION

(Editor's Note—Some months ago the Burns & McDonnell Engineering Co. of Kansas City, Mo., issued a pamphlet entitled, "A Guide to the Operation of Sewage Treatment Plants." Reproduction of this valuable matter in this magazine has been postponed until it could be reproduced in full.)

The design of a sewage treatment plant vitally affects its efficiency, but no plant has ever been designed which will continue to operate satisfactorily without attention. Unfortunately neglect of these plants seems to be the rule rather than the exception. The amount of labor required is, of course, dependent somewhat upon the size of the plant, but regular attention is essential for the efficient working of any plant. It may be that a short time each day will suffice, but the small amount of attention required does not justify omitting it altogether.

The care of a plant is not difficult and any intelligent man who will follow instructions can operate a plant successfully. A recognition by the city officials that the plant requires attention and an operator willing to follow directions conscientiously and give the necessary attention are the essentials.

A sewage treatment plant neglected and giving bad results always gives grounds for criticising the city administration and frequently the city officials blame the designing engineer, when the fault is really lack of care and attention. A poorly designed and cheaply built plant with good care and attention in operation will often give far better results than the finest kind of plant which may be neglected in operation.

In a recent decision of the Texas Court of Civil Appeals damages, due to negligent operation of a sewage disposal plant, were awarded a private individual from the City of Honey Grove, the court holding that the liability of the city does not differ from that of an individual who so wrongfully and negligently manages his property as to injure another person. The jury made the finding of fact that the alleged nuisance was abatable by the exercise of ordinary care in the operation of the plant.

The following guide to the operation of sewage treatment plants is based upon 25 years' experience in the design of sanitary projects, numbering over 120 plants and involving an expenditure of $7,500,000.00. It does not purport to be a complete set of instructions, but represents an attempt on our part as consulting engineers to stimulate the interest of the city officials in their treatment plants and an endeavor to co-operate for the efficient operation of these plants.

No guide to the operation of treatment plants can cover all cases and at times unforseen problems may arise due to a period of neglect or to local conditions which cannot be solved by the regular operator. At such times expert advice will be required and cities should confer with consulting engineers or the sanitary engineer of the State Board of Health. The employment of engineers to advise concerning operation of plants and closer co-operation with State Boards of Health would go far toward transforming many well-designed plants from a state of neglect to one of efficient operation.

Nature of Sewage

Great variation in quantity and quality of sewage exists in different cities, due to entrance of seepage water, roof water, and industrial wastes into the sewers. For economical and efficient operation of a treatment plant it is desirable that a minimum of seepage and no roof water

be allowed to enter. Fresh sewage is desired for Imhoff tank treatment. Some industrial wastes, such as tar and oil from gas plants and refineries and washings from garages are particularly troublesome; stringent regulations should be enforced by cities to prevent such wastes from reaching the sewers to keep their treatment plants operating efficiently.

No raw sewage should be by-passed except when absolutely necessary.

Grit Chambers

Screens should be cleaned at least once per day and more often if necessary.

Grit chambers should be cleaned out whenever the accumulation of grit becomes such that grit tends to wash through; removed contents should be buried, or dried on sludge bed.

Septic Tanks

Inlet and outlet channels and weirs should be kept clean.

Sewage solids will accumulate as settled sludge or floating scum; contents of tank should be disturbed as little as possible. When combined depth of scum and sludge equals one-quarter of the tank depth, the solids should be removed, preferably in spring or fall, when sludge will dry quickly.

Removed material may be buried, or dried on sand beds. No open flame lamps should be taken into any septic tank on account of the explosive character of accumulated gases.

Imhoff Tanks

Channels.—All channels should be cleaned at frequent intervals and always before reversal of flow, using care that deposits are not washed into tanks.

Settling Chambers.—When putting Imhoff tanks into service for the first time, or after pumping out and cleaning, if sewage is concentrated and flow heavy, the tanks should be filled with the more dilute night flow or clear water and the amount of sewage admitted to the tanks gradually increased, in order to build up the bacterial action.

Non-settleable material, such as oil and grease should be skimmed off daily, burying or burning it.

Settleable material behind baffles and scum on surface of settling chambers should be skimmed off daily, throwing it into gas vents.

All vertical walls and sloping bottoms of settling chambers should be cleaned with rubber squeegees slowly, forcing the deposit entirely through the slot, taking care that the deposit is not stirred up and carried into outlet.

When reversing channels are provided the flow through the tanks should be reversed every week or two, previously skimming off all floating materials behind inlet baffles and squeegeeing all wall surfaces between baffle and end wall at inlet and allowing time for settlement.

Gas Vents.—The scum in the gas vents should be broken up daily by sprinkling with water or agitating with a rake to release the entrained gases and any material which cannot be made to settle should be removed and buried or burned.

If foaming occurs and cannot be controlled, the city should advise with its consulting engineer or the sanitary engineer of the State Board of Health.

Sludge Chamber.—Sludge should not be allowed to accumulate nearer than 18 ins. to the slot at the bottom of the settling chamber. The surface of the sludge may be determined by means of a wood or sheet iron plate attached to a wire or light rod.

Sludge should be removed at intervals by opening valves slowly on sludge pipes, it being better to remove small amounts frequently than large amounts infrequently.

Sludge should be drawn off slowly to allow continuous settlement of sludge around base of sludge pipe; only well-digested sludge should be withdrawn, known by its brownish-black color, more or less granular and frothy appearance, and faint tarry or rubbery odor as opposed to the grayish color, sticky and pasty appearance and foul odor of partly digested sludge.

Late each fall the entire amount of digested sludge should be withdrawn to provide sufficient storage capacity for winter sludge.

Vertical and horizontal sludge pipes should be cleaned by rodding to break up old deposits before opening valves. The sludge pipe may be backfilled with water or settled sewage after drawing sludge.

At intervals of several years, dependent upon local conditions and kind of plant operation, the tanks may require to be pumped out and cleaned out thoroughly.

Sludge Beds

Sludge should not be drawn upon the bed until all dried sludge has been removed therefrom; well-digested sludge only should be dried upon the bed and should be drawn to a depth preferably not over 6 to 8 ins. and never over 12 ins.

When thoroughly dried the sludge

should be removed, being careful to remove as little filter sand as possible, and may be used for filling in low places without nuisance, or for lightening and furnishing humus to heavy soils.

Thin layers of sand should be applied to the bed from time to time to compensate for losses during removal of sludge.

Dosing Chamber

Before starting the siphon should be filled with water and all pipe connections to the siphon should be kept continuously air-tight.

The sides and bottom of the dosing chamber should be cleaned down occasionally, and all floating material should be skimmed off frequently.

Sprinkling Filters

Sprinkling nozzles should be examined daily and kept clean.

The surface of the stone should be kept free from leaves, papers, and vegetable growth.

In case organic growths in the bed and moth-flies with their larvae become troublesome, chemicals such as caustic soda, copper sulphate or hypochlorite of lime may be used in proper quantities for their control.

When the condition of the surface becomes such that free percolation is not secured, the surface stone should be removed, washed, screened and replaced; at longer intervals, dependent upon kind of operation and quality of stone, the entire bed may require washing and screening.

Final Settling Tank

The sludge should be removed frequently so that it will not become septic.

Contact Filters

The apparatus for filling and emptying the beds should be examined frequently and kept in perfect operation.

The surface of the stone should be kept free from foreign material and vegetable growth.

When the stone becomes clogged with sewage solids, at intervals of five years, more or less, the entire bed of stone will require to be removed, washed, screened and replaced.

Sand Filters

Sand beds should be dosed alternately to allow cleaning, resting and drying. The distributors should be regulated to secure even distribution of sewage.

Before dosing any accumulated sludge should be removed and the bed raked lightly to a depth of ½ in. to break the surface.

When the bed becomes clogged so that sewage will not percolate, the surface sand should be scraped off to a depth of 1 in. and raked. At longer intervals new sand of situable quality must be added to the bed.

Teams and heavy loads should not be driven over the bed. Holes should not be dug into the sand to pass sewage directly to drains and any wash-ins should be repaired at once. No growth of vegetation should be allowed on the bed.

In the northern states the sand should be piled or ridged in late fall for winter operation to prevent ice from freezing to the sand, and every opportunity utilized for cleaning the bed.

GREENSBURG, IND., GAS AND ELECTRIC CO. STORES FUEL OIL IN CONCRETE TANK

By R. F. Lee, 302 West First St., Greensburg, Indiana.

The Greensburg Gas and Electric Company of Greensburg, Indiana, has provided a very convenient and substantial method of storing its fuel oil for a 250 h.p. Deisel type engine direct connected to generator.

The company at first intended to construct a steel tank above ground, but was soon convinced that the hazard from lightning, fluctuating temperature of oil with the surrounding temperature, maintenance expense and extra pumping facilities warranted the investigation of underground tanks. On the other hand, the company found tanks constructed of concrete which were serving their purpose very satisfactorily.

Plans prepared by the Truscon Steel Company were adopted. These plans conformed to the recommendations and specifications for storage reservoirs of the American Concrete Institute.

The tank as designed and built is 70 ft. long by 30 ft. wide by 9 ft. 11 ins. high, outside dimensions. The floor is 8 ins. thick, reinforced with expanded metal; the walls are 12 ins. thick reinforced with Kahn and rib bars; and the roof is joist construction, the joists being 5 ins. wide and 10 ins. deep with a 3 in. slab on top. There is a partition wall through the center of the tank which serves as a support to the roof as well as dividing the tank into two compartments.

Excavation was made with slips after the material had been loosened by plowing or picks. Solid rock was reached at a

depth of 6 ft. The floor was then placed with the edges formed to key to the walls. A galvanized strip 8 ins. wide sealed the joint. Dowel holes were drilled in the solid rock along the center of the walls and dowels inserted to engage the walls and thus avoid any movement of them. Forms were started on the floor and raised to position and braced. The walls were constructed in one continuous operation. The forms and reinforcing for the roof were placed and the roof and manholes built.

After the roof had hardened for two weeks and before the supporting timbers had been removed a top covering of 18 ins. of earth was placed with teams and slips.

Following the removal of the inside forms an oil proofing of calcium silicate was applied to the inside walls and floor in four coats, 24 hours apart, by the use of a hand pump and 50 ft. of garden hose and nozzle.

The cement was obtained from local dealer; sand and gravel shipped from Columbus, Indiana, unloaded by hand, hauled in wagons and fed to mixer by wheel barrows; and water was from the city supply. Concrete was mixed by an 11 cu. ft. capacity, steam driven Smith mixer and placed in forms by two-wheeled concrete carts.

During the last 2 ft. of excavation, placing of floor, building of wall forms and until the walls were partially built seepage water was removed by a 3 in. centrifugal pump, driven from the flywheel of the engine on the mixer.

The tank as built holds 125,000 gals. of oil. The oil is conveyed to the tank by a 3 in. pipe line from a siding 2½ blocks distant at an elevation of about 17 ft. above the top of the tank. The author was the contractor on this job.

STUDIES OF BUILDING HEIGHTS LIMITATIONS IN LARGE CITIES

Editor's Note: The Chicago Real Estate Board recently issued a book entitled: "Studies of Building Heights Limitations in Large Cities," which is one of the most valuable books on certain phases of Zoning yet published. The following review of the book was written by Wm. Artingstall, Civil Engineer, 1206 Tribune Bldg., Chicago, who was the only engineer on the Chicago Zoning Commission appointed about two years ago.)

To the Engineer, Architect and the City Planner, questions treating of the various phases of Zoning are sure to attract attention. Unfortunately, however, few publications expose the fundamentals that enter into this important subject. Not so with the latest contribution to the subject just issued by the Chicago Real Estate Board through its Committee on Zoning under the direction of its chairman, Charles M. Nichols.

The Chicago Real Estate Board, during the past year desired to secure first hand information for its members and instituted a series of meetings as a means of disseminating the results of serious and intensive studies on the effect of high buildings and their relation to the subject of Zoning. Although these meetings were intended primarily for the education of its members, public interest became so aroused that it was necessary to utilize their large assembly hall in order to accommodate the "outsiders" desiring to attend. The mimeographed proceedings were soon exhausted but the Board authorized publication of the transactions and enriched them with contributions from nationally recognized authorities.

Appreciating our own limitations, no attempt is here made to review the various topics treated in the present volume of about three hundred pages; but, there are usually two sides to every question and the seemingly desirable or undesirable features are ably presented by their sponsors. We cannot, however, resist the temptation to mention the classical contribution of Mr. George C. Nimmons, the well known architect, in which he predicts the "Passing of the Skyscraper." "The diminishing rate of return," states Mr. Nimmons, "will in the near future prohibit the erection of extraordinarily high buildings for investment purposes," and he presents ample data to support his statement. Corroborative supporting data is contributed in a paper by Mr. Carl Schultz, president of the National Association of Building Owners and Managers. The latter has access to considerable data not available to the ordinary person and while his contribution is valuable, it is doubtful if the engineer will agree with some of Mr. Schultz's elastic conclusions or sanction a disregard of established economic facts. Building construction did not cease in 1907-8 and in 1917 because a legal limitation was imposed on height. These dates are too recent to forget the issuance of 'Certificates of indebtedness' during the 'black panic' of 1907 or the 'priority orders' which certainly were not granted for the construction of office

buildings during the late war. While some of us have very vivid recollections that there was a stringency in the money market for several years after the World's Fair boom (Chicago, 1893) that probably had far more effect on the building construction than did any city ordinances.

There is an extremely valuable exposition of the principles and practice of Zoning by Mr. Edward M. Bassett, chairman of the New York Board of Appeals, and a preface by the same authority. Another particularly instructive paper is that showing the Relation of High Buildings to Fire Hazard and Panic, by Sidney Williams, of the National Board of Fire Underwriters.

Public Health, Public Safety, Traffic and Transit, and Economic Considerations form other chapters, while Regulations in European and American Cities, and digests of various zoning ordinances add to the value of the publication.

The book has been reviewed by many of the daily papers and monthly publications and favorably commented upon at length by the Economist which states that "this is the most complete investigation on the subject ever yet undertaken."

"Studies on Building Heights Limitation in Large Cities," 300 pages. Cloth, $2.60 postpaid. Chicago Real Estate Board.

HARDNESS OF LARGE PUBLIC WATER SUPPLIES IN THE UNITED STATES

The difficulty of using hard water in the home is rather generally known. Much more serious troubles, however, are encountered in the industrial use of hard water and large amounts of money are spent each year in softening hard water for industrial use and in repairing damages resulting from the use of unsoftened hard water.

If the hardness of a water, expressed in the ordinary way as equivalent calcium carbonate, is less than 50 parts per million comparatively few persons notice the hardness in ordinary use. Such water may be called soft.

If the hardness is between 50 and 100 parts per million most persons would notice it but not be greatly troubled by it. Practically all industrial plants, where hardness is detrimental, would find it profitable to soften the water. It might bet called slightly hard.

Water with hardness between 100 and 200 parts per million hard without any qualification. Treatment is profitable for household use and for nearly every industrial use where hardness affects the value of a water. Water with hardness over 200 parts per million may be called very hard. Very few waters used for public supplies have hardness over 400 parts per million.

Analysis of water from the public supplies of over 300 large cities in the United States show that the average hardness of the surface water supplies in parts per million is 85 and of the ground water supplies is 226. Surface supplies are used by 34,000,000 of the 39,000,000 inhabitants of these cities. The general average hardness for all supplies is, therefore, 99 parts per million.

The hardness of some of the larger supplies is much below the average. The Boston supply, the Catskill supply of New York City, and several smaller supplies have hardness of less than 25 parts per million. The Croton supply of New York City and the Delaware River supply of Philadelphia have a hardness of about 50 parts per million.

The hardness of the water from Lake Michigan used in Chicago is about 130 parts per million. Other cities on Lake Michigan and the other Great Lakes use water with about the same hardness.

The average hardness of the large water supplies of states along the Atlantic coast and the east Gulf of Mexico is less than 55 parts per million except for Florida. The average hardness of the four large supplies of Florida is 296 although the hardness of the Pensacola supply is only 3. Public supplies in the Central States are nearly all hard or very hard. A number of them are softened in connection with their filtration for sanitary purification.

The foregoing matter is an abstract of a paper by W. D. Collins, Chief of the Quality of Water Division of the U. S. Geological Survey, presented recently before the Philadelphia Section of the American Chemical Society. The full paper was a discussion of material prepared for publication, within the next few months, as a water supply paper with the title: "The Industrial Utility of Public Water Supplies in the United States.

Construction News and Equipment

LIGHT MOTOR TRUCK HAULAGE AS APPLIED TO THE CONSTRUCTION OF CONCRETE HIGHWAYS

By A. E. Horst, Secretary-Treasurer of Henry W. Horst Co., Rock Island, Ill.

Probably the most serious of all consideration in connection with successful planning of the completion of highway contracts should be given to the problem of transporting materials which go into the construction of the highway,—from the base of delivery to the road proper.

INVESTMENT—SINGLE UNITS			
	TYPE 1	TYPE 2	TYPE 3
NUMBER BATCHES HAULED	1	2	4
WEIGHT-LOAD IN TONS HAULED	1.6	3.2	6.4
COST TRUCK COMPLETE-READY TO OPERATE	$ 1,000.00	$ 4,000.00	$ 5,000.00
LICENSE ONE YEAR	12.00	15.00	60.00
LIABILITY PROPERTY INSURANCE	42.00	42.00	48.00
FIRE-THEFT INS-ONE YEAR	20.00	50.00	60.00
STORAGE 12 MONTHS	48.00	60.00	60.00
NET TOTAL	1,122.00	4,167.00	5,228.00
INTEREST @ 7%	78.00	293.00	366.00
TOTAL INVESTMENT	1,200.00	4,460.00	5,594.00
AVER EXP. PER YEAR	700.00	1,793.00	1,844.00
OPERATING COSTS -	GAS 25¢ PER GAL - OIL 60¢ PER GAL		
	TYPE 1	TYPE 2	TYPE 3
GAS, PER MILE TRUCK OPERATION	2.5¢	5.0¢	6.2¢
OIL	.5¢	.5¢	1.0¢
TIRES	1.5¢	5.0¢	6.0¢
REPAIRS	2.0¢	3.5¢	4.0¢
TOTAL	6.5¢	14.0¢	17.2¢

CHART NO. 1—BASIC FIGURES FROM WHICH CHART NOS. 2 TO 5 WERE BUILT UP. THE ACTUAL FIGURES USED IN THESE GRAPHS ARE SHOWN IN TABLE I.

The three methods of such transportation in common practice today are:

1. Industrial Railway.
2. Heavy Trucks.
3. Light Trucks.

I find it a fact that many contractors do not know definitely what their hauling costs are. They may know that it cost a total of so many thousand dollars to haul the material on a certain job which they have completed, but to pull this total cost down and analyze it properly is a matter of mere guess in most cases.

After having especially discussed this subject with a number of contractors who should be in a position to know exactly what their costs are, I find it little wonder that a real salesman of trucks can make his costs look so low that he is able to sell, for a particular job, a fleet of trucks the operation of which will show actual costs far in excess of estimated costs. Until we analyze these costs we are in no position to check up definitely on whether or not trucks are likely to deliver according to the predetermined estimate.

Of course a truck manufacturer may show by figures or otherwise that his particular truck is most adaptable for hauling material on highway contracts. However, it is for the contractor himself, who is obliged to purchase trucks, use them, maintain and operate them and keep them in storage or occupied during the season that they are not in use on highway work, to decide which is the best investment and which trucks ought to be purchased.

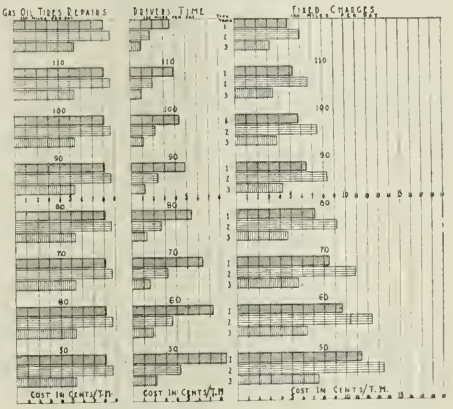


CHART NO. 2—GRAPHS SHOW, ON THE LEFT SIDE, GAS, OIL, TIRE AND REPAIR COST. IN CENTER, DRIVER'S TIME. ON RIGHT, FIXED CHARGES. ALL ON BASIS OF TON MILE AND UNDER DESIGNATED MILES PER DAY COMPARING THREE TYPES OF TRUCK; TYPE 1, SMALL; TYPE 2, MEDIUM; TYPE 3, LARGE. FIXED CHARGES ARE DEPRECIATION PLUS LICENSE, INSURANCE, STORAGE AND INTEREST EXPENSE.

Of assistance in determining the eco-

TABLE I—ELABORATED STATISTICS OF CHART NO. 1 ON BASIS OF DAILY RUN OF 50—60—70—80—90—100—110—120 MILES.

	Miles a day		50			60			70			80	
1.	Working days per year		150			150			150			150	
2.	Miles per year		7,500			9,000			10,500			12,000	
3.	Average mile haul		1.5			1.5			1.5			1.5	
4.	Trips per day		17			20			23			27	
		No. 1	No. 2	No. 3	No. 1	No. 2	No.3	No. 1	No.2	No. 3	No. 1	No. 2	No. 3
5.	Tons hauled each trip	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4
6.	Ton miles per day	41	82	164	48	96	192	55	110	220	65	129	260
7.	Investment per unit	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000
8.	Charge off per year	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844
9.	T. M. hauled each year	6,160	12,300	24,600	7,200	14,400	28,800	8,250	16,500	3,300	9,750	19,400	39,000
10.	Fixed cost per T. M.	11.4	13.5	7.4	9.7	12.4	6.4	8.5	10.9	5.6	7.2	9.2	4.7
11.	Driver cost per 150 days	525	525	525	525	525	525	525	525	525	525	525	525
12.	Driver cost per T. M.	8.5	4.3	2.1	7.3	3.6	1.8	6.4	3.2	1.6	5.4	2.7	1.3
12a.	Driver plus fixed cost per T. M.	19.9	17.8	9.5	17.	16.	8.2	14.9	14.1	7.2	12.6	11.9	6.
13.	Gas, oil, tires, repairs per mile	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2
14.	Gas, oil, tires, repairs T. M.	7.9	8.5	5.2	8.1	8.4	5.4	8.3	8.9	5.5	8.	8.7	5.3
14a.	Driver, plus gas, etc., T. M.	6.4	12.8	7.3	15.4	12.	7.2	14.7	12.1	7.1	13.4	11.4	6.6
15.	Total cost T. M.	27.8	26.3	14.7	25.1	24.4	13.6	23.3	23.	12.7	20.6	20.6	11.3
16.	Theoretical trucks needed 435 T. M. per day	10.6	5.3	2.7	9.	4.5	2.3	7.9	3.9	1.9	6.7	3.4	1.7
17.	Actual trucks needed	11	6	3	9	5	3	8	4	2	7	4	2
18.	Investment in fleet	11,000	24,000	15,000	9,000	20,000	15,000	8,000	16,000	10,000	7,000	16,000	10,000
	Six Miles Work												
19.	Fixed cost	3,900	4,700	2,600	3,300	4,300	2,200	2,900	3,800	1,900	2,500	3,200	1,600
20.	Gas, oil, etc.	5,700	4,400	2,500	5,300	4,100	2,500	5,100	4,200	2,400	4,600	3,900	2,300
21.	Total cost	9,600	9,100	5,100	8,800	8,400	4,700	8,000	8,000	4,300	7,100	7,100	3,900
22.	Remaining investment	7,100	19,300	12,400	5,700	15,700	12,800	5,100	12,200	8,100	4,500	12,300	8,400
	Twelve Miles Work												
23.	Fixed cost	7,800	9,400	5,200	6,600	8,600	4,400	5,900	7,600	3,800	5,000	6,400	3,200
24.	Gas, oil, etc.	11,400	8,800	5,000	10,600	8,200	5,000	10,200	8,400	4,800	9,200	7,600	4,600
25.	Total cost	19,200	18,200	10,200	17,200	16,800	9,400	16,000	16,000	8,600	14,200	16,200	7,800
26.	Remaining investment	3,200	14,600	9,800	2,300	11,400	10,600	2,200	8,400	6,200	2,000	9,600	6,800

TABLE I CONTINUED—ELABORATED STATISTICS OF CHART NO. 1 ON BASIS OF DAILY RUN OF 50—60—70—80—90—100—110—120 MILES.

	Miles a day		90			100			110			120	
1.	Working days per year		150			150			150			150	
2.	Miles per year		13,500			15,000			16,500			18,000	
3.	Average mile haul		1.5			1.5			1.5			1.5	
4.	Trips per day		30			33			37			40	
		No. 1	No. 2	No. 3	No. 1	No. 2	No.3	No. 1	No.2	No. 3	No. 1	No. 2	No. 3
5.	Tons hauled each trip	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4
6.	Ton miles per day	72	144	288	80	160	320	89	178	356	96	192	384
7.	Investment per unit	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000
8.	Charge off per year	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844
9.	T. M. hauled each year	10,800	21,600	43,200	12,000	24,000	48,000	13,300	26,800	53,400	14,400	28,900	57,600

10.	Fixed cost per T. M.	6.5	8.3	4.3	5.8	7.5	3.8	5.3	6.7	3.5	4.9	6.	3.2
11.	Driver cost per 150 days	525	525	525	525	525	525	525	525	525	525	525	525
12.	Driver cost per T. M.	4.9	2.4	1.2	4.4	2.2	1.1	3.9	2.	1.	3.6	1.8	.9
12a.	Driver plus fixed cost per T. M.	11.4	10.7	5.5	10.2	9.7	4.9	9.2	8.7	4.5	8.5	7.8	4.1
13.	Gas, oil, tires, repairs per mile	6.5	14.	17.2	6.6	14.	17.2	6.6	14.	17.2	6.5	14.	17.2
14.	Gas, oil, tires, repairs T. M.	8.1	8.7	5.4	8.1	8.7	5.4	8.1	8.6	5.4	8.1	8.8	5.4
14a.	Driver, plus gas, etc., T. M.	13.	11.1	6.6	12.5	10.9	6.5	12.	10.6	6.4	11.7	10.6	6.3
15.	Total cost T. M.	19.5	19.4	10.9	18.3	18.4	10.3	17.3	17.3	9.9	16.6	16.6	9.5
16.	Theoretical trucks needed 435 T. M. per day	6.	3.1	1.5	6.5	2.7	1.3	4.9	2.4	1.2	4.5	2.3	1.1
17.	Actual trucks needed	6	4	2	6	3	2	5	3	2	5	3	2
18.	Investment in fleet	6,000	16,000	10,000	6,000	12,000	10,000	5,000	12,000	10,000	5,000	12,000	10,000
	Six Miles Work												
19.	Fixed cost	2,200	2,900	1,600	2,000	2,600	1,300	1,800	2,300	1,200	1,700	2,100	1,100
20.	Gas, oil, etc.	4,500	3,800	2,300	4,300	3,800	2,300	4,100	3,700	2,200	4,000	3,700	2,200
21.	Total cost	6,700	6,700	3,800	6,300	6,400	3,600	5,900	6,000	3,400	5,700	5,600	5,300
22.	Remaining investment	3,800	13,100	8,500	4,000	9,400	8,700	3,200	9,700	8,800	3,300	9,900	8,900
	Twelve Miles Work												
23.	Fixed cost	4,400	5,800	3,000	4,000	5,200	2,600	3,600	4,600	2,400	3,400	4,200	2,200
24.	Gas, oil, etc.	9,000	7,600	4,600	8,600	7,600	4,600	8,200	7,400	4,400	8,000	7,400	4,400
25.	Total cost	13,400	13,400	7,600	12,600	12,800	7,200	11,800	12,000	6,800	11,400	11,600	6,600
26.	Remaining investment	1,200	10,200	7,000	2,000	7,800	7,400	1,400	7,400	7,600	1,600	8,800	7,800

CHART NO. 3—LEFT SIDE SHOWS DRIVER'S TIME PLUS FIXED CHARGES. RIGHT SHOWS TOTAL COST, BOTH ON BASIS OF TON MILE AND ON THREE TYPES OF TRUCK OPERATING 50 TO 120 MILES PER DAY.

nomical equipment to purchase are the following conditions:

General Conditions

1. Distance materials are to be hauled.
2. Will the road support the wear and tear of heavy traffic?
3. Time lapse before getting onto subgrade after rain.
4. Investment allowed in estimate for hauling equipment.

Investment

1. Comparative original costs.

CHART NO. 4—GRAPHS ON LEFT SHOW REMAINING INVESTMENT AND ON RIGHT SHOW FIXED AND OPERATING COSTS, THE THREE TYPES OF TRUCK OPERATING FROM 50 TO 120 MILES PER DAY USING A 6 MILE JOB WITH AVERAGE HAUL OF 1.5 MILES AS BASIS OF COMPARISON.

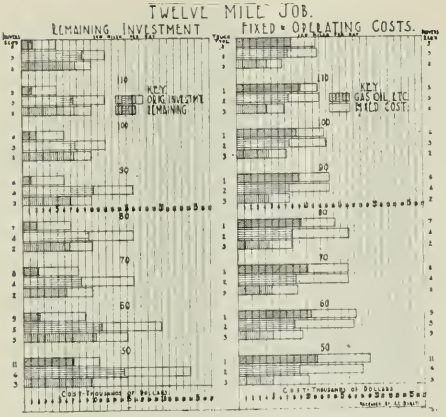


CHART NO. 5—LEFT GRAPHS SHOW REMAINING INVESTMENT AND RIGHT GRAPHS SHOW FIXED AND OPERATING COSTS, THE THREE TYPES OF TRUCK OPERATING FROM 50 TO 120 MILES PER DAY USING A 12 MILE JOB WITH AVERAGE HAUL OF 1.5 MILES AS BASIS OF COMPARISON.

2. Comparative depreciation.
3. Comparative investment in proportion to load-per-day carried.

Operation and Maintenance

1. (a) Ease of securing drivers.
   (b) Rate of pay.
2. (a) Ease of securing experienced mechanics.
   (b) Rate of pay.
3. (a) Ease of securing mechanical parts and comparative costs.
   (b) Will stocking of parts be necessary?
   (c) Likelihood of delay in waiting for parts.

COMPARISONS

	SIX MILE JOB — CASE I			TWELVE MILE JOB — CASE III		
	TYPE 1	TYPE 2	TYPE 3	TYPE 1	TYPE 2	TYPE 3
MILES PER DAY	120	100	80	120	100	80
NO TRUCKS	5	3	2	5	3	2
INVESTMENT FLEET	$5,000	$12,000	$10,000	$5,000	$12,000	$10,000
FIXED CHARGE	1,700	2,600	1,600	3,400	5,200	3,200
GAS OIL ETC	4,000	3,800	2300	8,000	7,600	4,600
TOTAL COST	5,700	6,400	3900	11,400	12,800	7,800
REMAINING INVESTMENT	3,300	9,400	8400	1,600	6,800	6,800
APPARENT DIFFERENCE BETWEEN TYPE 1 AND TYPE 3		$1,800			$3,600	

	SIX MILE JOB — CASE II			TWELVE MILE JOB — CASE IV		
MILES PER DAY	100	80	60	100	80	60
NO TRUCKS	6	4	3	6	4	3
INVESTMENT FLEET	$6,000	$16,000	$13,000	$6,000	$16,000	$13,000
FIXED CHARGE	2,000	3,200	2,200	4,000	6,400	4,400
GAS OIL ETC	4,300	3,900	2,500	8,600	7,800	5,000
TOTAL COST	6,300	7,100	4,700	12,600	14,200	9,400
REMAINING INVESTMENT	4,000	12,800	12,800	2,000	9,600	10,600
APPARENT DIFFERENCE BETWEEN TYPE 1 AND TYPE 3		$1,600			$3,200	

CHART NO. 6—SHOWS BASIC FIGURES FROM WHICH GRAPHS ON CHART NO. 7 ARE BUILT UP.

4. Cost of tires.
5. Life of tires.
6. Comparative consumption of gasoline and oil.
7. Comparative cost of maintenance of road for various type of trucks.

The answers to most of the above considerations are self-evident yet to what extent such affects the cost of transportation we do not know exactly, which gives one reason for this paper.

In order to avoid generalities and arrive at some definite conclusions, let us assume the following:

1. Grades not to exceed 4 per cent and road conditions similar to those found in the states of Indiana, Illinois, Iowa and Michigan.
2. Material to be hauled in proportion

TABLE II—ANALYSIS OF TON MILE COST.

Investment Single Unit.

	Type 1	Type 2	Type 3
Number of batches hauled	1	2	4
Weight of load in tons hauled	1.6	3.2	6.4
Cost of truck complete ready to operate	$1,000.00	$4,000.00	$5,000.00
License, one year	12.00	15.00	60.00
Liability and property insurance, 1 year	42.00	42.00	48.00
Fire and theft insurance, 1 year	20.00	50.00	60.00
Storage, 12 months	48.00	60.00	60.00
	$1,122.00	$4,167.00	$5,228.00
Interest at 7%	78.00	293.00	366.00
Total investment	$1,200.00	$4,460.00	$5,594.00
Average expenditure per year	700.00	1,793.00	1,844.00
Depreciated in	2 yrs.	3 yrs.	4 yrs.

Operating Costs—Gasoline 25c Gal., Oil 60c Per Gal.

	Type 1 Cents	Type 2 Cents	Type 3 Cents
Gasoline per mile truck operation	2.5	5.	6.2
Oil per mile	.5	.5	1.
Tires per mile	1.5	5.	6.
Repairs per mile	2.	3.5	4.
Total	6.5	14.	17.2

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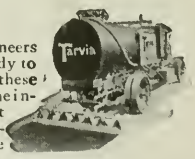

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batches to the mixer and not dumped on sub-grade.

3. The use of turntable to turn trucks at the mixer.
4. Gasoline—25 cts. gallon.
5. Lubricating oil—60 cts. gallon.
6. 10-hour day.
7. 150 working days per year.
8. 800 sq. yds. 7½-in. paving laid daily.

With these assumptions in the background, let us classify trucks of 2 ton capacity and less as light trucks. Let us depreciate them over 2 years of 150 working days each, thus making the average yearly expenditure on a truck one-half of its original cost, (one-half of $1,000) plus yearly expense of say $200, or a total of

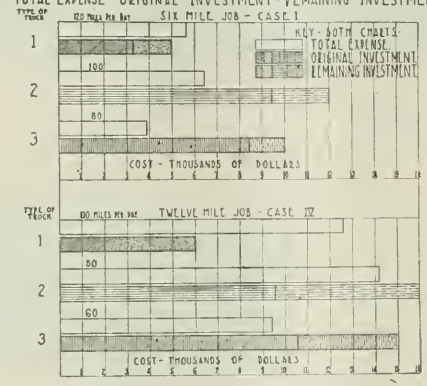
COMPARISONS
TOTAL EXPENSE - ORIGINAL INVESTMENT - REMAINING INVESTMENT
SIX MILE JOB - CASE I
KEY - BOTH CHARTS
TOTAL EXPENSE
ORIGINAL INVESTMENT
REMAINING INVESTMENT
COST - THOUSANDS OF DOLLARS
TWELVE MILE JOB - CASE IV
COST - THOUSANDS OF DOLLARS

CHART NO. 7—GRAPHS SHOW COMPARATIVE TOTAL OPERATING COST, ORIGINAL INVESTMENT AND REMAINING INVESTMENT ON THREE TYPES OF TRUCK, FIRST, ON COMPLETION OF 6 MILE JOB OPERATING 120, 100 AND 80 MILES A DAY, AND SECOND, ON BASIS OF COMPLETION OF A 12 MILE JOB OPERATING 100, 80 AND 60 MILES A DAY.

$700. This class of trucks in the accompanying graphs is designated as Type 1.

Similarly, for the sake of comparison, let us classify trucks of 2 ton to 3½ ton capacity as medium trucks, depreciated over 3 years with average yearly expenditure of $1,793. These are designated in graphs as Type 2, while all trucks of over 3½ ton capacity will be classified as heavy trucks, depreciated over 4 years with average yearly expenditure of $1,844. These trucks are designated as Type 3.

Bearing these assumptions and classifications in mind, let us turn to graphic representation of the facts supported by Table I, "Elaborated Statistics of Chart No. 1 on basis of Daily Run of 50, 60, 70, 80, 90, 100, 110 and 120 Miles."

Chart No. 1 lists the statistics from which graphical presentations on Charts 2, 3, 4 and 5 are built up, while Chart No. 6 gives statistics on which the graphs on Chart No. 7 are built up.

From "Fixed and Operating Costs" as shown on Charts 5 and 6, it would seem that Type 3 Truck is the cheapest to use. Further analysis, however, shows this apparent showing to be as deceiving as is the thought of comparative loads hauled without comparison of number of trips made.

For sake of consideration, nevertheless, let us refer to Chart 5, where in case of "Fixed and Operating Costs" the showing seems to be in favor of Type 3 Truck and in view of these graphs and of the apparent saving of $3,200, as shown on Chart No. 6, consider the following:

(a) Can we afford to have but 3 trucks for handling 12 miles of work? Suppose one truck breaks down, we operate but 66 2/3 per cent efficient, whereas with one of six light trucks out of commission we operate 84 per cent efficient.

(b) Could we afford to take chances with heavy loads on highways which are being paved because they cannot take care of the present ordinary traffic?

(c) Can we afford to put one additional man every one-half mile on our sub-grade over and above those required to keep the grade in shape for light trucks? (This additional expense alone amounts to over $1,600 on a 12 mile job).

(d) Compare a jerky operation with 3 trucks of 4 batches each with the more continuous operation of 6 light one-batch units.

(e) Compare the investment of $15,000 in a fleet of 3 large trucks for 12 miles of work after which we still have $10,600 tied up in 3 units with an investment of $6,000 in 6 lighter trucks and, after 12 miles of work, but $2,000 tied up in 6 units.

There is no doubt that each type of truck has its place in the transportation problems of the highway contractor. It is only possible, however, to secure the best and most economical equipment for each job through an intelligent analysis of all factors involved in the operation of the truck.

In other words, let us make an accurate analysis of the Ton-Mile Cost as given in Table II.

The foregoing paper was presented at the the recent annual convention of the American Road Builders' Association.

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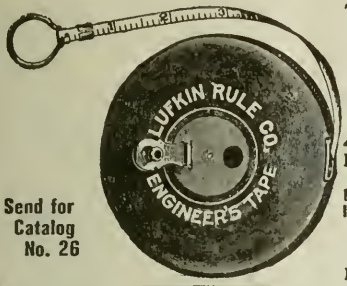

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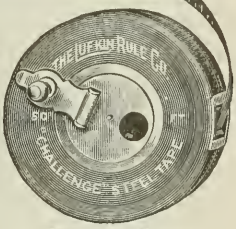

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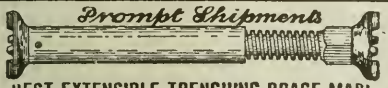

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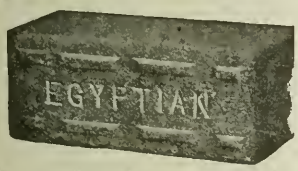

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EVINRUDE PUMP IMPROVEMENTS

The Evinrude Motor Company of Milwaukee announces a recent improvement in the bearing equipment of its centrifugal pump, hundreds of which are now used by contractors, engineers, municipalities, bridge builders, dredging companies and public service corporations.

To support the pump shaft at the lower end, a ball thrust bearing has been provided. This bearing supplants the lignum vitae plug heretofore used. After a six month's test it has been found that the ball bearing greatly increases the life of the lower bearings and also makes the pump operate more freely and effectively. This improvement is of special value because it can be installed in those pumps now in the hands of users.

PURCHASE OF MIETZ OIL ENGINE BUSINESS

The Charter Gas Engine Company of Sterling, Ill., U. S. A., announces the purchase of the entire "Mietz" Oil Engine (also known as "Mietz and Weiss") business, heretofore carried on at 128-138 Mott St., and 430 East 19th St., New York City, by the August Mietz Corporation and the Reliance Oil Engine Corporation. This effects a merger and consolidation, under one management, of two of the oldest and best known internal combustion engines in the world.

The "Mietz" Oil Engine was the pioneer Semi-Diesel oil engine of the world. The first "Mietz" Oil Engine was built in 1895 by Mietz and Weiss, and since that time there have been placed in service some 375,000-h.p. in all parts of the world. The "Charter" engine was the pioneer gasoline engine of the world, the first one having been built in 1886 and so far as is known it was the first commercially successful engine to use liquid fuel in the world.

The Charter Gas Engine Company is now moving from New York City to their plant at Sterling, Ill., all of the physical assets, comprising the "Mietz" Engine and in the meantime is filling repair orders from New York City, so that there will be no interruption in repair service to "Mietz" engine users.

It is announced that "Mietz" engine users will be able from now on to obtain prompt and reliable repair service for any "Mietz" Engine ever built.

A number of the personnel of the August Mietz Corporation organization have been engaged for work by the Charter Gas Engine Company insuring a thorough working knowledge of the manufacture of "Mietz" Engines.

In order to handle the added business properly, arrangements for additional floor space have been completed, whereby the area of the present Charter plant is almost doubled.

A NEW SUBGRADER

A new unit of paving equipment is the Lakewood steel subgrader illustrated herewith.

This steel subgrader is a development of the Lakewood wood frame subgrader, which has been used for the past several years and has proved of such advantage to both contractors and engineers that mechanical subgrading is rapidly becoming the standard method.

The steel subgrader has been developed to meet the demand for a heavier unit, and one which could be equipped with scarifying teeth on the front member to assist in breaking up the subgrade ahead of the blades. The wood frame subgrader will still be furnished, but the steel tool will be supplied to contractors desiring a stronger and heavier machine.

The purpose of the subgrader is to plane the subgrade to the exact depth for the road slab. It travels on the side forms and is pulled by a roller or tractor. Steel cutting blades, which can be adjusted so as to take very fine cuts, trim the subgrade to exactly the depth desired.

The machine will cut to either a flat or crowned subgrade and can also be adapted for the new Illinois design of subgrade, which provides for a slab considerably thicker at the edges than at the middle. A turntable pedestal allows the machine to be raised off the forms and turned in the middle of the road to allow the roller or trucks to pass.

EDITORIALS

WHEN IMPROVED HIGHWAYS PARALLEL INTERURBAN RAILWAYS

When improved highways parallel interurban railways it is only a question of time until motor truck and bus traffic reaches proportions that cut into the rail receipts and this, of course, precipitates a form of warfare with all the unpleasant manifestations commonly associated with a business war. As long as the truck and bus lines act merely as feeders to the rail lines they are in high favor with the railway owners, but as soon as direct competition begins, friendship ceases and the fight is on. Naturally enough the interurbans are interested in self preservation but in their efforts to protect themselves they use many arguments, the soundness of which the public should examine with great care. The public interest is paramount and if it serves the convenience and economic needs of the public to have truck and bus lines operating over a certain highway joining two or more important centers of population, and if the operation of these truck and bus lines injures an interurban or short line steam railway which they parallel, the thoughtful section of the public can hardly escape the conclusion that the rail lines are simply out of luck.

It is a serious question, right now, whether or not the interurbans can long survive. Many feel that these utilities are entering a state of functional obsolescence. All will hope that the interurbans can keep operating at a profit by improving their transportation service, especially in freight and long haul passenger traffic and by selling electric energy for power and lighting purposes, for no one likes to see invested capital lost, but the owners of these utilities must realize that it is up to them to survive through service and not through the elimination by law of truck and bus competition, however skillfully this elimination may for a time be disguised as "regulation." The interurbans use many arguments against motor transport lines which will not stand up against the force of logic and common sense. Much complaint is made that trucks and buses operate over the public highways, built at public expense, while the interurbans must buy their right-of-way, do their own grading and construction, pay for their tracks, etc. After reciting at length these and other points of fundamental difference between rail lines and rail traffic, and highways and highway traffic, the rail magnate or manager suddenly shifts his position and expects the public to regard as similar two forms of transportation which he has demonstrated are fundamentally dissimilar. Comparison from any standpoint shows that the interurbans are under a natural handicap, in this struggle, and they can scarcely hope to persuade the public to impose artificial handicaps on highway transport merely to safeguard the investments and profits of the rail owners. Evolution and progress have always injured what they have rendered obsolete, as a matter of course, while contributing to the general advancement and welfare of the race.

Many of the fallacies in the arguments advanced on behalf of the interurbans become obvious when we consider what the effect of commercial air traffic may be on highway, as well as on rail transportation. If, or when, air traffic becomes commercially feasible and well developed in this country, and it is pointed out that air craft do not require roadways of any sort on which to run, like tracks and pavements, that air transport does not require bridge and drainage structures, and has other natural advantages over both rail and highway transport, are we to be asked to impose artificial handicaps on the air operator merely to offset the natural handicaps under which rail and highway transport must always operate?

As we have intimated, if the interurbans could have all the profitable intercity business while the truck and bus lines were required to run out into the forests and swamps, if they ran at all, the interurbans would feel that all was well, but the public would derive little benefit from such a condition, to say nothing of truck and bus operators.

Before the steam railways came there were many cities. The railways naturally first connected the largest cities, passing

also through as many smaller cities as was considered feasible en route. Other towns grew up along these steam railways. When the interurbans came they were very naturally and very properly located where they would serve the public best and this naturally caused them to parallel the steam railways which had developed the line of travel. It will be remembered the steam lines didn't like this very well. Incidentally, the highways were here first and all rail lines have paralleled the highways, often overshadowing the importance of a highway for many, many years. Following the same sensible procedure the highways carrying the heaviest traffic were the first ones selected for hard surfacing and these roads are the ones connecting the larger cities, thus throwing the rail lines and the highways into direct competition, just as the electric lines came into competition with the steam lines. The electric line men are now talking like the steam line men did 20 years ago.

It is well to keep these fundamentals in mind in examining the arguments of the interurbans against the improvement and use of highways.

TRUCK AND RAIL COOPERATION

In discussing truck and rail cooperation it is well to point out at the outset that this is likely to exist only where the railroad is one of considerable mileage. Occasionally we see expressions of friendship for motor transportation by some rail man and if we do not look closely we are likely to miss the point that he represents a long road, a trunk line, in practically all cases. Short haul freight is not profitable to long railroads, but it is to the short railroads if the short lines make any profit at all. The truck is a real help to the long line, but may be a dangerous competitor to the short one. Thus we can expect little true cooperation between short line railroads and motor transport, now or hereafter.

Up to about 30 miles, as a rule, the truck, on good roads, is more economical than the railroad; for some conditions and some classes of freight the truck has the advantage for distances considerably exceeding 30 miles, but that figure seems to be a fair average based on experience to date.

The great majority of intercity trucking enterprises have come to grief either because the operator has attempted the economically impossible or because he has known little or nothing of cost accounting and has fixed his rates at less than the cost of the service. The possibilities and limitations of the truck will not really become known until it is taken up by men of brains and responsibility who will learn their costs and charge accordingly.

One prominent rail official representing a trunk line (the Erie) recently said: "The time has come when the nation's railroad facilities are so heavily taxed by the enormous tonnage offered that there is only one way in which we may get freight hauled, and that is by asking business men to employ motor trucks for the short hauls, say, up to 30 miles or so, thus releasing railroad facilities and equipment for the longer haul which can go by no other means."

He frankly and truly states, also, that freight destined for short distances can be transported by motor truck at a price cheaper than by rail to the shipper and, therefore, to the consumer. This is due to the fact that the cost of handling in railway terminals, especially in the larger cities, is so great.

The rail official quoted also said: "All who have kept up with our modern transportation problems admit that the motor truck is the necessary adjunct and not the competitor of the railroad, indispensable to economic short hauling. The railroads will have to be rid of the burden of the short haulage into and out from cities of magnitude, not only because it doesn't pay the railroad, but also because it doesn't pay the shipper or the consumer. Isn't it right, isn't it sound social policy, isn't it just to all concerned to devote facilities and equipment to the longer haul freight, which if not moved by rail cannot be moved at all, and ask the business men and manufacturers to get their short-distance hauling done by motor trucks?"

This railway official has developed a very sound conception of truck and rail cooperation. Proper coordination of the longer and stronger railroads with well financed and well officered motor transport companies will help greatly in clearing up the transportation muddle.

ESSENTIAL FEATURES IN CONCRETE PAVEMENT DESIGN

To the Editor:—

In reading the article by Mr. Warren in the March issue of "Municipal and County Engineering" on "Developments in Concrete Pavement Design," I find much that is of interest and miss much that seems to me important.

It is now 30 years since the first cement concrete streets were built in this country and a vast amount of literature concerning the subject has been produced without authoritative answer to either of several important questions which must have occurred to the engineer who designed the first concrete pavement and answered by him in his own way. The problems all of us meet when we plan a pavement are the same and must be determined in each case in accordance with the conditions peculiar to that case. They are, generally speaking: (a) the preparation and protection of the subgrade or foundation of the pavement, (b) the design of the slab to meet the requirements of present and future traffic, (c) the proper finish of the surface so that it will give the least resistance to traction and the greatest resistance to abrasion, and (d) curing so as to preserve the qualities that have been built into the pavement. And frequently in municipal practice the further problem of how to prevent someone, either financially or officially interested, from so changing the plan as to seriously injure the pavement.

I have seen but few pavements in the design of which all of these problems have been fully solved.

The subgrade may be well prepared but is rarely well protected unless nature has provided the protection.

A great deal has been said in advocacy of sub-drainage of the roadbed, and I would emphasize all of it, but no amount of sub-drainage will prevent a stiff, waxy, clay subsoil from becoming entirely too wet, during a wet Fall, for the good of a concrete slab resting upon it. Neither will a well finished subgrade of ordinary soil give adequate support to the slab when the slab is subjected to the warping effect of unequal expansion of top and bottom due to difference of temperature.

In my own practice I have endeavored to meet these problems by means of: first, adequate curbing, extending well below the subgrade and set on a porous foundation which provides drainage; second, a cushion of clean sand and gravel or crushed rock spread upon the subgrade. Three inches of sand and gravel or 4 ins. of crushed rock, are sufficient usually to prevent forming a frost bond between the slab and the subgrade.

The design of the slab will necessarily be made with reference to the warping effect of unequal expansion. For this reason I have prefered to construct the slab with a longitudinal joint in the center whenever the width is greater than 18 to 20 ft. I have met with considerable official and popular opposition to this and have, in some instances, been overruled. In each such instance the result has been unsatisfactory. In this city we have several cases in which pavements, identical in other respects and constructed the same season, show marked contrasts in their present condition and in each case the advantage is in favor of the center joint.

Other questions enter into the design of the slab, chief of which are the proportioning of the ingredients and the proper thickness. The prevailing opinion of writers seems to favor rich mixtures and thick slabs, which probably are justified by laboratory practice and tests. But I am quite convinced that concrete may be too rich and consequently have an undue tendency to crack. I have secured the best results with a 1:2½:4 mix, with the surplus water well worked out or absorbed by a rich mixture of cement and sand floated into the top when finishing.

As to the proper thickness of slab I am entirely open to conviction in any case. I paved a lumber yard in 1912 with a 4-in. slab on filled ground. It is subject to very heavy traffic, both as to weight and number of loads, but is in excellent condition and shows but little effect of wear.

I daily observe 8-in. slabs on the state highway, subject to lighter traffic, showing the effect of abrasion and badly cracked after less than half the period of service. So I am satisfied that the question must be solved with reference to other conditions as well as the volume and weight of traffic.

Probably the treatment of the foundation is the most important factor in determining the slab thickness. It is doubtless best to play safe by making it thick enough. I believe that, given a subgrade fit to build on, 8 ins., and possibly less, is ample thickness for the support of any traffic. And this gives a margin of 2 ins. for loss by abrasion.

The conclusions I draw from all my observations and experience, supplemented by the experience of others which have come to my knowledge, are briefly as follows:

1. That the destructive forces against which we must build protection into the road are: (a) The warping effect of unequal expansion which invariably produces longitudinal and diagonal cracks during the second and third season whenever the slab is too large, especially when it extends across a crown. (b) Frost action upon the subgrade either in heaving or in freezing the slab to the moist earth which continues to expand while the slab contracts after such adhesion. Frost probably plays a considerable part in the destruction of heavily reinforced pavements, owing to the great difference between the expansion of steel and of concrete. (c) The weight and abrasion of traffic.

2. If faults develop in the pavement they are due to one or more of these causes and that all design and construction should be carried out with a constant purpose of reducing their effects to the minimum.

3. Maintenance charges are, largely, payment for the failure of the builder to produce an ideal job. This is especially true of maintenance during the first few years. Of course the ideal job presupposes ideal conditions of soil either natural or constructed. It also presupposes an adequate plan faithfully carried out.

However I did not set out to write a treatise but merely to record a few observations along lines which have received less attention from writers than their importance merits.

There is much to be determined in this as in other fields of activity and I submit these observations with the fullest appreciation of the possibility that accurate data obtained from comprehensive surveys and elaborate field experiments may modify them somewhat. But the subjects to which they relate will always remain of prime importance.

Very truly yours,

CHAS. F. NESBIT.

Dixon, Ill., April 16, 1923.

TRAFFIC CENTER LINES ON ROADWAYS

(Editor's Note: Following is the full text of the report of the Committee of the National Highway Traffic Association on "Traffic Center Lines on Roadways," presented at the annual meeting of the Association on May 10, 1923, by the chairman, Mr. Frank T. Sheets, Illinois State Superintendent of Highways, Springfield, Ill.)

The use of traffic center lines on highways is becoming more and more popular in the United States. In the case of a road having a paved width sufficient to accomodate two lines of traffic, the safety of the highway users may be increased from 25 to 50 per cent by the addition of a traffic center line. This conclusion has been reached after an observation of the habits of traffic on two track roads where a center line has been introduced. Further it is based upon the unsolicited complimentary remarks which have been received from the traveling public immediately after such a line was introduced.

When a traffic center line is used, the drivers no longer pass each other with a more or less uncertain clearance between the vehicles, but approach each other with confidence, using the center line as a positive visible gauge on the driver's side, and knowing that the clearance thus afforded will insure absolute safety in passing without any danger of running off the unseen outside edge of the pavement.

On curves the traffic center line is of even greater advantage than on the tangents, and even if not used on the latter, it should be painted on all curves having a radius less than 1,000 ft. This center line should extend not less than 400 ft. beyond the beginning and ending of the curve.

In the case of the so-called non-rigid or flexible types of pavement construction on macadam or other flexible bases, the use of traffic center lines might tend to force traffic into well defined lanes and thus cause rutting or undue wear. However, on heavily traveled roads, the safety of the traveling public is of greater importance than the safety of the pavement surface. In the case of the so-called rigid types of pavement, such as portland cement, concrete, brick, bituminous concrete or sheet asphalt on a concrete base, which are the predominating types in this country, the traffic center line will materially increase the structural safety of the pavement by tending to eliminate travel near the extreme edges of the pavement, where the outside edges and the unprotected corners caused by construction joints or by transverse contrac-

tion cracks are the most dangerous and critical sections from a structural standpoint.

One of the embarrassing defects encountered in concrete pavement slabs having a width greater than 16 ft. is the formation of unsightly longitudinal cracks brought about by the combined stresses produced by nature and traffic. To eliminate such cracks, the center of the pavement must be thickened to a dimension not justified by economy; however, this may easily be circumvented by introducing a longitudinal center construction joint dividing the normal two-crack country pavement having a width of 18 ft., into two 9-ft. sections. Slabs 9 ft. in width have never caused any difficulty so far as longitudinal cracking is concerned. By proper interlocking and tying together of these two 9-ft. strips, the interior portion of the pavement may be made practically as strong as an unbroken slab, and certainly far more efficient than a pavement divided by an irregular longitudinal crack. This center construction joint may be kept filled with bituminous material and painted with a line approximately 3 ins. in width. In this manner, the traffic center line and the longitudinal construction joint may be introduced in one operation, with the result that the unsightly longitudinal cracking is eliminated, traffic safety is assured, and highway engineers may cease to perpetuate the indefensible evil practice of causing doubt, criticism, and mistrust in the mind of the traveling public by designing and building pavements which fail structurally by longitudinal cracking even before traffic is introduced.

The combined center line construction joint and painted traffic center line are being used in the state of Illinois on all pavements built on the 4,800-mile state trunk line highway system which is being pushed to completion at the rate of 1,000 miles per year, and also on all county roads in the State.

SPECIFIC PRINCIPLES OF GOOD PROFESSIONAL CONDUCT FOR ENGINEERS

A compilation of specific principles of good professional conduct for engineers has just been prepared by the Practice Committee of the American Association of Engineers, as requested by the Board of Directors, to supplement the code of ethics of the association. The principles, which follow, are stated in short sentences, and are based upon cases passed by the Practice Committee since 1919 and approved by the Board:

Part 1. *Relations of the Engineer to the Public*

1. The Engineer should regard his duty to the public welfare as paramount to all other obligations.

2. He should not use his professional standing as a means of sponsoring or promoting commercial or other undertakings of a speculative character.

3. He should scrupulously avoid connection, by act or omission, with any illegal or questionable undertaking or participation in any enterprise inimical to the public welfare.

4. He should not advertise in self-laudatory language or in any other manner derogatory to the dignity of his profession.

5. He should avoid any publicity giving the impression that technical service in technical matters can be dispensed with; or that technical proficiency along any line is easy of acquisition; or that exaggerated returns may be expected from any limited course of technical instruction.

6. He should avoid any questionable statements or any statements couched in language that would convey a false impression, in any of his reports, advertisements or articles.

7. When retained to report on any property or project, he should not accept as compensation any stock or other interest in the property or project, or any other contingent fee which could in any way consciously or unconsciously influence the nature of his report and its conclusions.

8. He should avoid entering into any private combination which would restrict free individual competition for professional employment. The matter of proper engineering fees and the methods of making proper tenders on engineering work should be left to professional organizations in order that their backing should inspire public confidence.

9. He should refrain from using any improper or questionable methods of soliciting professional work.

10. He should participate in clean politics and should strive to be a force to assist in the cleansing of politics.

11. He should take an active interest in the public welfare in behalf of which

he should ever stand ready to volunteer his special knowledge, skill and training for the use and benefit of mankind.

Part II. Relations of the Engineer to Clients and Employers

1. The engineer should pursue his professional work in a spirit of strict fidelity and full loyalty to his clients and employers.

2. He should inform a client or employer of any business connections, interests or affiliations which might tend to influence his judgment or impair the disinterested quality of his services.

3. He should accept compensation for his services in connection with any work from one source only, except with the full knowledge and consent of all the interested parties.

4. He should regard and maintain as confidential any information obtained by him relating to the business affairs and technical methods or processes of a client or employer.

5. He should not engage in any outside work without the full knowledge and consent of his employer.

6. When connected with any work, he should not accept commissions, outside employment, promise of employment, or any other consideration from a contractor engaged upon that work.

7. He should have no business dealings or connections with any client of his employer without the full knowledge and approval of his employer.

8. He should entertain no offers of employment or other considerations from a third party, when such may in any way influence his actions or decisions with respect to the relations which may exist between such third party and the Engineer's employer or client.

9. He should not accept commissions or other considerations for specifying or recommending supplies, equipment or service.

10. He should not split fees as commissions for securing work, nor work with other engineers on a split-fee basis unless assured that his client is not deceived thereby.

11. He should have no interest direct or indirect in any materials, supplies or equipment used in the construction work of his client or in any firms receiving contracts for his client's work without informing his client in advance of the nature of such interest and obtaining his sanction.

12. He should not engage in the independent practice of engineering without the knowledge and sanction of his employer, and under no circumstances should he compete with his employer on the basis of lower fees.

Part III. Relations of Engineers to Employes

1. The Engineer should treat his employes or subordinates in a spirit of fairness, with due regard and consideration for their personal welfare and professional advancement.

2. There should be a professional bond between employer and employe when both are engineers, which will dictate and impel reciprocal interest and mutual consideration.

3. The Engineer should pay adequate salaries commensurate with the importance and responsibility involved in the service.

4. He should encourage the professional pride of his employes or subordinates in their work and should offer them every means of protecting their reputations and the quality of the work entrusted to them by not interfering with the proper performance of the duties for which they are responsible.

5. He should recognize the freedom of his employes to change employment and should in no way hinder employes or subordinates in bettering their condition.

6. He should not discharge an employe, nor withhold employment from him, nor discriminate against him in any way on account of his affiliations or activities in any professional, political or religious organization.

7. He should respect his employe's right to freedom of thought, speech and outside activity as long as the same does not impair the efficiency and value of the employe's service.

8. He should see that his employe is adequately covered by insurance against risk of casualty arising from his work.

9. In advertising or offering employment, he should refrain from any misrepresentation as to the conditions and permanency of such employment.

10. If in public employ, he should assume the responsibility of consistently protecting the interests of his subordinates.

11. He should make every effort to provide steady employment for his employes and when forced to discharge an employe he should give the most generous notice possible and exert every reasonable effort to assist the employe in finding another position.

Part IV. The Engineer's Relations to Other Engineers

1. The Engineer should not by word, act or omission, injure falsely or maliciously, directly or indirectly, the professional reputation, prospects or business of another Engineer.

2. He should not attempt to supplant another Engineer after definite steps have been taken toward his employment.

3. If employed in conjunction with another Engineer, and by the same client, he should not review and comment conclusively upon the work of the other Engineer except with his full knowledge and consent or unless the connection of such other Engineer to the work has been previously terminated.

4. He should not use unfair means to effect his professional advancement or to injure the chances of another Engineer to secure and hold employment.

5. He should not attempt to inject his services into a project at the expense of another Engineer who has been active in developing it.

6. He should not interpose between other Engineers and their clients when unsolicited. When solicited, he should avoid any possibility of doing a brother Engineer an injustice.

7. He should not seek or solicit a position occupied by another Engineer.

8. He should not attempt to secure work on the basis of lower salaries or fees.

9. He should be courteous, fair, considerate in his dealings with other Engineers.

10. He should not criticise the work of other Engineers except when regularly engaged to do so; and he should not attempt to secure the work for himself through criticism.

11. He should not commercialize his affiliations with, or official position in, any technical organization.

12. He should not use his professional affiliations to secure the confidence of other Engineers in speculative commercial enterprises.

13. As a member of any professional organization, he should avoid any act tending to promote his own interest at the expense of the dignity and standing of the organization.

14. As an officer of a professional organization, he should sedulously avoid any appearance of using his position for personal advertising.

15. He should cooperate in upbuilding the Engineering profession by exchanging professional information and experience with his fellow Engineers and students of Engineering and by contributing to the work of engineering societies, schools of applied science and the technical press.

16. He should regard himself as a debtor to his profession and should dedicate himself to its advancement.

TRAFFIC ACCIDENTS IN RELATION TO STREET AND HIGHWAY LIGHTING

By Charles J. Stahl, Manager Illuminating Engineering Bureau, The Westinghouse Companies, South Bend, Ind.

The first use of street lighting was to prevent crime and the first illuminant was the pine knot or firebrand which served merely as a pathfinder in the primitive settlements of man. Then came lamps made from the skulls of animals or nut shells in which oil was burned. With the advance of civilization there came a growing tendency to do more and more of the world's work under artificial lighting. In the early days no one ventured on the streets after dark except on most urgent business and then only when accompanied by a body guard of torch and cudgel bearers. Even during the present generation there have been in many American cities certain sections dangerous to traverse after nightfall.

Street lighting has had a fascinating development which up to about 20 years ago was impelled almost entirely by man's desire for safety, comfort and peace of mind. The fundamental motive was crime prevention. Today it is still the fundamental consideration but other motives have grown to be of almost equal importance. Briefly stated these other considerations are:

1. Accident prevention.
2. The "City Beautiful" idea.
3. Business stimulation.

I am mentioning this to show that up to recent times the requirements of traffic were almost entirely neglected in the lighting of streets and as for highways what little has been done is hardly a beginning on the thousands of miles of intercity highways which along with the automobile have grown to such great importance in our national life. Fortunately the requirements of good street lighting from the standpoint of preventing crime are to quite an extent the requirements for safe and comfortable traffic, except that the latter requires higher intensities of lighting. But unfortunately no national

or civic organizations have consistently advocated and fostered the use of ample and efficient street lighting.

Our first thought is that the electric light companies should be its advocate, but they unfortunately are very often forced to enter into contracts in which the rates allow no profit and not infrequently the street lighting business is actually taken at a loss to the electric light company supplying the power. Naturally they make no effort to increase unprofitable business.

For its value as a business stimulator merchants have here and there fostered local improvements but no highway association, or other allied societies, have so far undertaken extensive propaganda or educational work on the value of good street and highway lighting which in comparison with most other public services is high in proportion to its cost.

The time has come when in connection with our street lighting we must recognize that we have entirely different problems to face than ten or even five years ago, and the cause is the automobile. To the development of modern high speed traffic brought about by its extensive use must be charged practically all of the increase in street-traffic accidents.

According to the latest surveys the total annual fatal accidents on the railways of this country are 7,800 as against 15,500 fatalities due to traffic accidents. Therefore, the loss of life in traffic accidents is twice as great as in railway accidents. As to an evaluation of the annual personal and other property loss from automobile accidents, Dr. F. S. Crum, statistician for one of the large insurance companies of this country, states that while an accurate computation is not possible, the annual sacrifice is fully $1,000,000,000.

In 1906 there were less than 400 deaths in the United States from automobile accidents while in this year the total will exceed 15,000 which is an increase of about 3,800 per cent and the total is steadily mounting higher.

Stringent traffic regulations and educational publicity work have brought good results in many districts but they cannot overcome the effects of faulty vision caused by inadequate and improper street lighting. To determine how much value should be attributed to the proper illumination of streets as a factor in the prevention of accidents, a survey was made in a representative group of cities. In order to obtain uniformity in the reports, blank forms were prepared by the Engineering Department of the National Lamp Works providing for a charting or accurate tabulation of all traffic accidents in a given city during the period of one year. On these data forms returns were obtained from 32 representative cities such as Philadelphia, Boston and others, with a combined population of over 7,000,000. The period covered by the returns was in most cases from the middle of 1919 to the middle of 1920. Some of the essential facts derived from the data compiled are in condensed form as follows:

1. That of the 31,475 accidents reported, 1,678 or 17.6 per cent were night accidents due to inadequate lighting.

2. Applying this rate to all cities of the U. S. we find that no less than 567 fatal accidents occur annually due to inadequate lighting.

3. In addition to the suffering and loss of life an evaluation of the economic loss gives us the substantial amount of $54,000,000 chargeable to the lack of light and according to census reports the total annual expenditure for street lighting in the United States does not exceed $50,000,000.

The percentage of 17.6 arrived at as the proportion of night accidents which may be attributed to lack of light is undoubtedly an extremely conservative figure, for the streets of the cities covered by the survey were illuminated at night by artificial lighting of varying degrees of effectiveness. So in an individual city where the need for better street lighting is especially evident, night accidents chargeable to lack of light may run as high as 50 per cent.

Among manufacturers it is realized that great savings in the cost of production are brought about by a double-shift which spreads the overhead or fixed charges over 24 hours as against 8 or 12 hours. This practice may be followed with equal economies by applying the double-shift to trucking which, according to reports, has in some cases reduced trucking costs almost one-half, due to the increased utilization of equipment and terminal facilities. This night use of streets can be fully developed only by providing improved street lighting. The double utilization of crowded thoroughfares is advocated not only because of its economy from the operator's point of view, but to relieve day time congestion and to postpone the time when expensive duplicate thoroughfare construction will be required by the increasing volume of traffic.

In driving at night, whether it be a truck, passenger bus, or private car, the driver's vision depends upon the fairly constant illumination from the street lights, his own headlights, and the spasmodic, violent influence of approaching headlights. Excepting grade crossings, the greatest danger to automobile drivers is from glaring headlights and with the growth in automobile traffic it is evident that some solution of the headlight problem must be brought about. Apparently there are only two really effective solutions, namely:

1. The establishment of one way streets and interurban or trunk highways.
2. The lighting of trunk highways so that with dimmed headlights cars may be operated with safety and in comfort at the customary cross country speeds.

Efficient highway lighting fixtures have been developed and their use is being advocated by the leading manufacturers of street lighting equipment, and is sponsored by the Illuminating Engineering Society after considerable study and experimenting.

The cost of lighting a highway usually does not exceed five per cent of the cost of duplicating the highway in order to provide for one way traffic, so it is obvious that the second method is more economical than the first.

Many states have put into effect very definite regulations requiring the use of improved headlight lenses, governing their adjustment and various other details. Some have employed Illuminating Engineers and maintained a substantial force of traffic officers especially trained for competency in enforcing headlight legislation, but the most conscientious and persistent supervision has met with very little and unstable success. The solution lies in applying sufficient illumination to our main highways so that drivers will not need their headlights except as markers to define the width of the car or the limits of the area to be avoided in passing, and on city streets to make the approach of automobiles readily apparent to the pedestrian.

The precautions taken to protect the motoring public by posting all sharp curves, narrow bridges, steep grades and the like may be made to serve their full usefulness by proper highway lighting. At present this protection does not extend adequately beyond the hours of daylight.

Trucks as a rule operate at fairly low speed and at slow speeds headlights often afford little illumination so the driver is likely to strike obstructions or holes and do damage to both truck and highway. Many a load has been delayed for hours and sometimes for days because the driver misjudged the edge of the road bed and sank into soft ground. In addition to disrupting schedules and lowering the equipment utilization factor the road is injured when heavy loads ride on the very edge of the road bed.

The cost of good highway lighting is justified by these considerations alone and apart from thoughts of comfort and fear of holdups.

The foregoing paper by Mr. Stahl was presented at the annual convention of the Allied Motor Commerce (of Indiana) at Indianapolis, April 30, 1923.

CONSTRUCTION AND OPERATION OF WARREN, OHIO, WATER PURIFICATION PLANT

By S. N. Vance, Resident Engineer for Alexander Potter, Consulting Engineer, 50 Church St., New York City, and P. J. O'Connor, Superintendent of Filtration, Warren, Ohio.

The water works of Warren, Ohio, were privately owned. The city of Warren was no exception to the rule existing during the last of the war-period and the years succeeding it, when private companies refused or were financially unable to extend or enlarge their systems to keep pace with the growth of the cities.

In 1920 Warren, therefore, was faced with the necessity of purchasing its water plant or standing for an increase in rates, two or three times greater than those then obtaining.

The city retained the services of Alexander Potter, Consulting Engineer, to investigate the entire water works matter, including the question of ultimate source of supply for a greater city and an appraisal of the existing plant of the water works company. Later Mr. Potter was named to represent the city on a two member Board of Arbitration, which fixed the value of the plant at $687,500, which amount was accepted by both the company and the city.

After the award was agreed upon but before the city took possession of the plant, plans were prepared for the rehabilitation of the water works system, the construction of an adequate filter plant and a service reservoir to the east of the city to be constructed of reinforced concrete and built wholly above the surface of the ground.

In taking possession of the plant, the construction of a 6,000,000 gal. filter plant was immediately undertaken and contracts let within a month. The plant is located in the city of Warren at Summit street and Mahoning avenue and on the east bank of the Mahoning River.

Old Filter Plants

The original plant, built in 1895, had a capacity of 1,500,000 gals. per 24 hours, and while it was, no doubt, modern at the time of erection, the art of water purification has advanced so rapidly that today a plant of its type is so out of date that we will not devote more space to it.

To meet the demands for more water and to obtain less expensive operation, in 1917 the Trumbull Public Service Company erected a new and more modern mechanical filter plant. This plant was built on the same property but back from the river and consists of four 500,000 gal. units, two storage basins with a total capacity of 90,000 gals, which were under the filters, or tubs as they are called, and two settling or coagulating basins, each with a capacity of 250,000 gals. This plant was constructed of reinforced concrete with the superstructure of brick.

Unfortunately the plant was not so designed that it could be added to sufficiently to become a big plant; therefore, it could not provide but for a short time for the increasing demand for water, for both industrial and commercial uses. The size of the units were entirely too small, as a big plant with small units is very expensive to operate. In addition to this big handicap, the back half of each unit was covered with a low flat roof, which touched the water. The ice formation was therefore bad and in a very awkward place to remove. The coagulating basins were not covered and the ice formation caused the wall to crack.

The chemical feed devices as well as all of the valves were manually controlled, that is except the valves on the rate of flow controllers which were hydraulically operated.

As stated above, the plant could not meet the rapidly increasing demands, though an extreme effort was made and the plant taxed beyond what should be expected of any mechanical plant. It was often operated at 100 per cent over its normal rating.

The new plant was built of reinforced concrete with the superstructures of tapestry brick with stone trimmings, the inside of the filter building being of a buff pressed brick conforming with the old filter building. The plant consists of a mixing chamber with a chemical feed house and a storage room above, a coagulating basin and six 1,000,000 gals. per day filter units, with storage basins beneath the filter units. The plant is of the mechanical gravity type.

Mixing Chamber

The mixing chamber is 17x35½ ft. and 23 ft. deep, inside dimensions, and is divided into eight equal size compartments, each having an inverted pyramid bottom in which there is a sludge drain valve, the valves being operated by long extension stems from the floor above. Each of the eight compartments are divided in half by means of a baffle wall which extends from above the water line down to within 3 ft. of the sludge valves. A two-story superstructure, 17x17 ft. of brick with reinforced concrete floors is built over one-half of the mixing chamber. The top story of this building is used for the storage of the chemicals which are elevated to it by means of an electric hoist.

The first floor is used for chemical feed machines and their appurtenances for automatic proportionate feeding, gauges for the meters indicating the amount of raw water pumped, desk, lockers, etc. Provisions were made for duplicating the mixing chamber for future extensions.

Coagulating Basins

The coagulating basin is 90 by 51 ft. and 19 ft. deep, inside dimensions, and has no cover but a walk 3 ft. 9 ins. wide was placed on top of and around the outer walls and from this walk a baffle, constructed of plaster on metal laths, was suspended, extending 3 ft. down into the water, the idea being that only a thin ice would form under the walk and against the walls and thereby prevent the cracking of the outside walls. Soon after the plant was put into operation there was a cold snap, about 10 degs. below zero, and while 13 ins. of ice formed on the basin, under the walks it was only 1½ ins. in thickness.

A distribution trough extends across the inlet end of the basin. Into this trough the treated water is discharged. The top outer edge of the trough is 9 ins. below the normal water line, thereby forming a weir. Twelve inches from the trough is a baffle extending from 3 ins. above the normal water line to 3 ft. below; therefore, the water entering the basin must flow over the weir and under the baffle, which gives it a downward motion. About 35 ft. from the influent end of the basin is a cross wall extending up

to within 9 ins. of the normal water line and a weir is formed of the top. This wall is perforated, having 2 in. openings, 12 ins. on center in both directions, the first row of holes being 6 ft. from the bottom of the basin. Six inches from this wall and supported from it by brackets is a baffle wall extending 3 ins. above the normal water line and 18 ins. below. This baffle, as the one just described, causes the water to take a downward motion. The part of the basin between the influent trough and the cross wall has a flat bottom, in which there is embedded 3 in. acid proof tile laterals, spaced 2 ft. apart and each separate tile is 2 ft. long. with a ½ in. orifice in the center. This makes a strainer system bottom with ½ in. orifice 2 ft. 3 ins. on center one way and 2 ft. the other. These 3 in. laterals drain into channels, which in turn drain into 3 cast iron underdrains. The underdrains are 8 ins. and there is a quick opening gate valve on each line, these valves being located in a manhole just outside the basin.

It is found in practice that at least 60 per cent of the settling takes place in the first third of the tank. With an underdrain system such as described, constructed under the first third of the tank, the period between emptying the tank for cleaning can be extended for six or eight months by operating the quick opening valves daily to remove the accumulated settlement before it has an opportunity to compact and solidify.

At the effluent end of the basin there is another cross wall similar to the one above described. This wall extends up to within 2½ ft. of the normal water line, and the first row of 2 in. openings is up 10 ft. from the bottom of the basin. The wall is only 2 ft. 2 ins. from the end of the basin, and thus forms a small effluent chamber. The bottom of the basin between the center cross wall and the effluent chamber is the usual bottom with two 12 in. sludge valve drains. These valves are operated from the walk on top of the wall, the extension stem being on about 45 degs. and working through a universal joint. Provisions were made for duplicating the basin for future extensions.

Filters

The filter units or tubs are 19½ ft. by 20 ft., and 8 ft., 9 ins. deep. There is a pipe gallery in the center with 3 filters on each side, the normal rate of each being 1,000,000 gals. per 24 hours. The tubs, piping, etc., are arranged so that additional units may be added at a minimum cost.

Each filter unit has a gutter across the front end and there are three cast iron wash water troughs extending from the gutter to the back end of the filter, the weir or top of the trough being 24 ins. above the sand bed. The strainer system consists of 2-in. cast-iron laterals spaced 6-ins. on center and having 7/32 in. orifices in pairs spaced 4½ ins. on center. These orifices are on the underside of the laterals. The laterals discharge into 2 cast-iron manifolds, each having an area of 50 sq. ins., which discharge into the clear well beneath the filters.

The gravel which was placed on top of the laterals is in 6 layers and was very carefully screened and placed to come within the specifications, which were:

1st layer, 1½ to 2½-ins., 5 ins. thick.
2nd layer, 1 to 1½-ins., 4 ins. thick.
3rd layer, ½ to 1 -in., 3 ins. thick.
4th layer, ¼ to ½-in., 2 ins. thick.
5th layer, ⅛ to ¼-in., 2 ins. thick.
6th layer, 10-mesh to ⅛-in., 2 ins. thick.
Making a total thickness of 18 ins.

The sand was specially selected so that it would also meet the requirements of the specifications, which were that the effective size should be 0.35 to 0.45 mm. and a uniformity coefficient of not more than 1.70 mm. After the plant had been in operation for about a week, samples were taken from various parts of each bed and through the entire thickness and tested. The results of the test were an effective size of 0.39 mm. and uniformity coefficient of 1.62 mm.

The pipe gallery is designed with the main piping at the ceiling and in the center; from these the branches of the following sizes were taken for the individual units: 12 in. influent, 10 in. effluent, 14 in. wash, 6 in. rewash, and 16 in. sewer.

A 10 in. venturi type rate controller is placed in the effluent line from each unit. This controls the amount of water filtered. There is a large flume in the center of the pipe gallery which receives the discharge when the beds are washed, this flume being connected with a sewer which discharges into the river. The top of the flume is about 2½ ft. above the floor of the gallery and serves as a walk.

The operating platform is the floor above the pipe gallery. This floor is 2 ft. below the tops of the filters, thereby giving what is known as sunken platforms. There is no operating reason for this but as an architectural effect it is much more pleasing than to have the floor

at the top of the tubs. On the operating floor there is a marble operating table for each unit. Mounted on the table in one metal case is an indicating loss of head gage and an indicating and recording rate of flow gage. There is also on each table an operating handle, with an indicating device for controlling the valves, all of which are hydraulically operated. The small piping to the cylinders of the hydraulic valves is so arranged that the pressure may be taken from either the standpipe or the discharge from the pumps. The necessity of this is, that should the standpipe be empty for cleaning, painting or repairs, the valves could still be operated. For convenience an electric light was placed on each table.

At one end of the operating platform there is a 12 in. gage, connected to the wash water line of each separate unit, which registers the pounds pressure at which the filter bed is being washed. It is an easy matter therefore to get the desired rate which is 2-ft. vertical rise per minute over the sand area, which is equivalent to 15 gals. per sq. ft. per minute.

The average loss of head at which the beds are washed is 8½ ft. and they are washed for about 3 minutes. The filters are washed from the standpipe which is located just a few feet from the filter building. The standpipe has a capacity of 390,000 gals. and is at all times kept full, which gives a static head of 60 lbs. The wash water line is connected to the discharge of the pumps as well as to the standpipe. This enables the beds to be washed in case, for any reason, the standpipe is empty.

Since the water storage supply of the old plant was sufficient to fight a normal fire for only about 8 or 9 minutes, it was necessary that the new plant be erected and the old connected to it with the minimum amount of time that the filters be closed down. Due to a very careful design along these lines, the new plant was erected and the old connected up without once closing down the filters. The raw water pumps, however, were closed down several times in changing over the piping, but at no time for more than an hour. Sunday mornings, just about daylight, is the minimum rate of filtration for the week; therefore, when it is necessary to close down the pumps, this was the time selected.

Raw Water Supply

The water supply is taken from the Mahoning River. There is a dam constructed of reinforced concrete extending across the river. As a part of the dam and near the east bank is the intake chamber, the front and top of which is of gridiron construction, being made up of heavy iron bars spaced 2 ins. apart. These bars withstand the heavy knocks of large logs or other floating bodies that from time to time come down the stream. Inside the intake chamber there are two sets of screens which are removable and easily kept clean.

Located in the old pump house are three low lift single stage pumps, two with a capacity of 2,000 and one of 3,000 gals. per minute. These pump the raw water from the river to the mixing chamber. All the pumps are centrifugal and electrically driven. The water is delivered to the pumps through a 20 in. suction line and discharges into a 20 in. header. The discharge line is increased from 20 to 24 ins. just outside the pump house to allow for additional pumps for future extensions. Between the pumps and the mixing chamber there is a 24 in. check valve and a 24 in. by 14 in. venturi tube, this tube being connected to a Simplex indicating and recording gage which is located on the first floor of the chemical feed house.

The raw water piping is so designed by reversing the flow in some of the piping, that in case of emergency such as repairs to the check valve or venturi tube, the plant could be operated.

Chemical Feed

The alum and lime which are used in the treatment of the water are fed into the mixing chamber by means of two dry feed machines, which were built by the Pittsburgh Filter and Engineering Co. These machines are located on the first floor of the chemical feed house, each having a large storage hopper into which the chemicals are fed from the floor above. They are operated automatically and fed proportionately to the amount of water pumped. The automatic arrangement consists of diaphragms, orifices and piping and is connected to the venturi tube in the raw water line. The machines are driven by water motors, the same water that operates the motors is used to dissolve and wash the chemicals down into the mixing chambers. The lime is fed into the mixing chamber at the point where the raw water enters and is mixed for a short distance, then the alum is added and the two are mixed by passing over and under the baffles. The time of retention at the normal rate of 8,000,000 gals. per day is about 19½ minutes.

An emergency feed line was provided so that should repairs be necessary to any part of the raw water line or the basin, chemicals can be added directly to the pipe line. In the old plant the chemicals were fed only into the raw water line and both alum and lime added at one point.

Operation of Plant

The water is taken by gravity from the mixing chamber to the coagulating basins, leaving the mixing chamber in a 20 in. pipe. It is delivered into the distribution trough of the new basin by means of two 16 in. pipes. In the old basins new distribution troughs were built of wood and the water is delivered into each of these troughs by means of two 12 in. pipes. In all cases the delivery was made in two places to help in the distribution of the treated water.

In the new basin the water passes over the weir of the trough and under the baffle as above described then takes a slow travel towards the effluent end. About 60 per cent of the mud and bacteria are deposited in the first compartment of the basin which has the strainer bottom. The theory of the strainer bottom is that as a large part of the sludge is settled over this compartment, that by opening the 8 in. quick opening valves each day for a very short while the basin would be kept clean. The operating of the quick opening valves depends entirely on the amount of chemicals and that in turn depends on the quality of the water. While it is advisable to open them each day, due to existing conditions at the present time, they are opened every second day and are allowed to run until the water is clear which is about 3 minutes. The time of coagulation at the normal rate of 8,000,000 gals. per day is 3½ hours.

The water is taken by gravity from the effluent chamber of each basin by means of two 16 in. pipes. These are increased as they are connected together and finally enter the pipe gallery as a 30 in. pipe. The piping is so designed that the filters may be supplied from any or all of the basins, thus any basin may be by-passed to allow time for the basin to be washed. The piping is also arranged so that any one or all of the filters may be operated at any one time. This is true of both the old and new units. As stated above, the rate of filtration of any unit can be controlled.

The new clear wells were so designed and connected up with the old ones that there is in reality two clear wells. They are connected by means of a 20 in. pipe line in which there is a gate valve. Normally, this valve is open and the line serves as an equalizer, but by closing the valve either side can be by-passed and thus allow time for cleaning or repairs, should any be necessary.

Liquid chlorine is fed into each of the clear wells at a point about 14 ft. from the suction of the pumps. This point was chosen for feeding the chlorine because of the peculiar design of the old clear wells. They have a cross partition with an opening about 4 ft. square in it; therefore, all the water must pass through these openings at which point the chlorine is fed.

The high service pumps consist of two single stage and one double single-stage pump; all are centrifugal and are electrically driven. The piping is so arranged that they can be made to work in tandem, to obtain higher pressure for fires. The water may be pumped to the standpipe and be delivered from there to the city mains or it may be pumped directly into the mains, thereby by-passing the standpipe.

Laboratory

The laboratory is one of the very important points in the operation. Since the laboratory which was previously used was too small, it was necessary to build a larger one so that additional equipment could be installed. The laboratory, which is 12 ft. wide and 24 ft. long is located on the second story of the pump-house, which was formerly used as a storage for chemicals. There are two chemical tables, each 15 ft. long and 3 ft. wide, located in the laboratory. The table tops are finished in ebony asbestos wood. Underneath these tables and set back 6 ins., there are cabinets which are used for general storage. Above one of the chemical tables a cabinet was built; this cabinet has glass panel doors and is used for storage of chemicals for laboratory use. At one end of the chemical table there is a hood constructed of transite asbestos wood; the hood has a sliding door in which there are two glass panels. The laboratory is equipped with two Mar-Sla stone sinks and also has all of the necessary equipment to control the operation of the plant. A space of about 6 by 9 ft. in one corner of the laboratory is used for an office.

As to the work done in the laboratory, tests are made on the water taken at various points throughout the entire process; this is done that the plant may be operated at the highest possible efficiency. Each day tests are made for the following: Temperature, turbidity, alkalinity,

color, hardness, dissolved iron, total bacteria, colon bacillus communis, microscopical examinations and phenol. The alkalinity tests are made every hour, or more often if the condition of the water is bad or changeable. The plant is operated 24 hours per day.

There are three filter operators and also three assistant operators who work 8 hour shifts. Each man has one day off every week so that necessitates an extra operator who alternates shifts every other day in order to give the operators and assistants their day off. In addition to these seven men there is an extra man who makes repairs around the plant and is capable to act as operator or assistant in case any man is off on account of sickness or other things that might require an operator or assistant to be away.

In connection with the building of the new plant, the old original filter building, which was of no value except as junk, was removed and the space back-filled. The old pump house was renovated in general and a concrete floor built in it for the storage of chemicals, which is of such size as to allow the storage of a car load. This old building contains the boilers for the heating system, coal bins, the low lift pumps, the water meter testing apparatus, repair shop and general storage space.

In back-filling the old filter building, two of the old basins were maintained, one for a future screen chamber and the other for a manhole, containing the 20 in. check valve on the raw water line. The outer or river front wall was maintained as a retaining wall, and from this wall to the dam across the river a new reinforced concrete retaining wall was built. This makes a retaining wall 20 ft. above the normal water line of the river for the entire water front of the property.

The construction work was done by Mapes and Erway, General Contractors of Warren, Ohio. The filter equipment was installed by the Norwood Engineering Company, Florence, Mass., with Mr. James F. Torpey, Filter Engineer, as their representative on construction.

The water system in Warren is modern and the results being obtained are excellent. There are two very weak points in the system; one is the storage of filtered water, the other is the need of more city mains. A design has been made for a 6,000,000 gal. covered service reservoir to be built on Bolin Hill and also for the distribution mains over the entire city. The mains that are now being laid from time to time are in accordance with the above design. The need of the Bolin Hill Reservoir is appreciated by a great many, probably more especially by the Fire Chief than any other, and it is hoped that before a great while the construction work will start.

Cost of Filter Plant

The cost of the new filtration plant was as follows:

Mixing chamber, with chemcal feed house and storage room above	$ 18,579.02
Settling basin	35,254.64
Filter building complete, including clear wells, pipe gallery operating floor, filter tubs and the brick superstructure	40,324.71
Outside piping, including the venturi meters, making the connections from the old to the new piping, and relaying old piping	25,211.94
Removing and back-filling the old filter building, back-filling the low part of the property and back of the retaining wall. Repairs to the old pump house, walks, etc.	11,457.59
Chemical feed machines	2,950.00
Filter equipment	57,547.56
Retaining wall	8,184.00
Renovating old settling basins	1,761.11
Total cost	$201,270.57

REASONABLE INTERPRETATION OF STATE HIGHWAY SPECIFICATIONS IN NORTH CAROLINA

By C. N. Conner, Assistant Engineer, North Carolina State Highway Commission, Raleigh, N. C.

In order to secure a reasonable and rational interpretation of specifications the contract must be clear and definite, the engineers and contractors must be unprejudiced, intelligent and fair-minded; while the highway commission, itself, must have confidence in its engineers, and demand the respect of its contractors.

The commission should take care of policies and agreements, the engineer with design and supervision of survey and construction, the contractor should take care of the actual construction as called for in his contract.

All of this sounds very easy, but when

the personal equation enters in, trouble may or may not result.

Selfish, personal and opinionated decisions are usually disastrous. Any point in question should always be decided on its own merits with the "self" entirely eliminated.

There is often an honest difference of opinion, but if possible the specification should have but one interpretation. A thorough knowledge of the work itself on the part of the engineer and contractor will avoid many misunderstandings.

The old so-called "blanket clause" is becoming less and less popular; it means nothing or anything and is therefore worse than useless.

Contractors sometimes have said, when they sign a contract, that they are signing away everything but their wife and children; what can we engineers as interpreters of specifications say to this?

To the engineers' discredit, it can be said that contractors have been broken by unfair and unintelligent decisions.

Such things as this result in the contractor bidding on inspection and engineering instead of on the performance of the work itself, a condition which must and can be avoided by maintaining an organized engineering force which has definite specification, unselfish motives, and an average degree of intelligence.

It is a mistake for engineers, in North Carolina, for example, to copy verbatim, the specifications of another state or even the specifications of the Bureau of Public Roads. Conditions are not the same in all parts of the country; frost is a serious consideration in some of the northern states, but is of minor importance in others. A gravel road specification which can easily be met in Maine or Wisconsin will not fit the conditions at all in western North Carolina, where we must use the local material even though it be inferior to Maine and Wisconsin gravel.

Suppose, for example, a contract was let for a gravel surfacing, the engineer had copied a very drastic specification as to quality and grading of the material but had not investigated the local material, or at least, had not realized that it could not pass his specification; the contractor finishes his grading and starts using the local gravel for surfacing; the inspector finds that the gravel does not meet the requirements and that none can be found locally which does. What then? Who is to blame?

If the contractor is obliged to ship in material he will "go broke."

It is plainly necessary to make a reasonable interpretation of the specifications or to draw up a subsequent agreement permitting the use of the local material.

It is not difficult to draw up a specification for absolutely the best construction, but it does require considerable forethought to adapt the specification to local conditions, especially when good materials are scarce, local conditions vary by a wide margin, and economy must be exercised.

For these reasons North Carolina is building practically every type of road and is adopting that type which will best utilize local materials, serve traffic conditions, and maintain healthy competition in bidding.

On nearly every job of any magnitude the contractor raises the question as to whether or not he should perform a certain piece of work. To settle this the engineer must be familiar with his specifications (whether they be good or bad). The work, however, must be done. If it is within the specifications it should be paid for at the contract unit price; if not, a price should be agreed upon or the work paid for on a cost plus basis.

The practice of paying for extra work by increasing the quantities on some other item, such as throwing it into excavation or borrow, is not good business and should be avoided.

The phrase "with written permission of the engineer" is important to the engineer, as well as the contractor; it is nothing more or less than good business practice. It puts in writing the authority for doing work in a manner which may be different from that called for in the specifications.

Some contractors have performed work which they honestly felt was outside the specifications in order to avoid disputes with their engineers; this is not right. There is really no good reason why the contractor or his representative and the engineer or his representative cannot get together and discuss, peaceably, any point on the work. It is done in every other line of business; why not in ours?

The engineer or inspector who attempts to threaten or penalize a contractor by taking unfair advantage of his position, is in serious danger of losing his job. Unfair treatment of a con-

tractor by an engineer or his inspectors should never be countenanced.

Long arguments, however, are dangerout. Oftentimes an unreasonable or impractical requirement will creep into a specification, similar to the following:

"Piles must be cut when the sap is down."

Suppose a job were let in the month of May, must the contractor wait until the following winter before cutting and driving his piling?

Changes in North Carolina Specifications

Some points in connection with the 1923 specifications may be of interest. Under the 1922 specification for drainage ditches the engineer could require the contractor to bring material from a point 1,000 ft. away from the road and place it in embankments. This might prove to be unnecessarily expensive to a contractor if the ditch extended through swampy ground or a heavy thicket.

The question of payment for unavoidable overbreaks and slides has been finally settled by allowing payment for classified excavation.

To supplement the specifications and to make their interpretation uniform and clear, the roadway cross-sections will be given in detail on blue prints for each project.

The stations, on which a given section is to be built, will be listed under that section, so that on each project there will be several sections with a list of stations given under each.

There are several changes in the 1923 specifications which will undoubtedly assist the contractor without injuring the final quality of the work.

Lighter rollers will be allowed on fills with the result that more rolling will be done and the fills will have a longer time to settle before the surfacing is placed.

A minimum weight of two tons will be allowed, but if the weight of roller is less than three tons it must be made up of separate rings 4 to 8 ins. in width, which vary in diameter from 6 to 8 ins. They are commonly called embankment rollers and have been satisfactorily used on reservoir and levee work. Lighter rollers, five to ten tons, will be allowed on the subgrade for hard-surface work.

Placing fills in layers is still required, but each layer may be placed in two horizontal sections, provided the next layer above "breaks joint" with the one beneath.

The gravel specification has been revised to fit local conditions. The topsoil and artificial sand-clay specification has been separated into two items. The plowing and harrowing has been reduced from seven to three consecutive days and thereafter when the conditions are suitable.

The maximum size stone or gravel for coarse aggregate in concrete roadway and base course has been lowered from 2¾ ins. to 2¼ ins., and tabulated grading requirements have been made. Screenings as a part of the fine aggregate will not be permitted. This will or should result in a more workable concrete, which can be more easily furnished.

Progress on shoulder and ditch work must be kept up to within 4,000 ft. of the last surfacing laid. The shoulders and ditches may be built to the approximate section but not finally finished. This will give plenty of time for the soil to get settled and will prevent the subgrade from becoming soft and endangering the surfacing.

When cuts are widened to take borrow their depth must not be deeper than the adjacent subgrade.

The free haul limit on excavation and borrow will be 1,000 ft. and on topsoil, sand-clay and one course gravel will be 2,000 ft. Overhaul will be paid for at 1½ cts. per cu. yd. station of 100 ft.

Hauling over broken stone base course will be allowed provided it does not result in ruts.

The use of hydrated lime in roadway concrete may be employed up to 10% by volume of the cement. When lime is to be used, written permission from the engineer will be given and the lime furnished by the state f. o. b. siding. The contractor will be paid a fixed price per square yard for hauling and placing.

Separate measurement of materials will be required, as before, the measurement being made in vertical compartments in the batch boxes, when used, or in separate containers outside the batch boxes and then dumped into them. In the case of hand-finishing of concrete roadways, it will be necessary to screed the concrete with the steel screed at least twice; two screeds may be employed.

The sprinkling of concrete must be maintained and the contractors should look well to their pumping equipment, source and quantity of water available. The laying of concrete roadway cannot proceed unless that already laid is be-

ing properly cured. The wetting for curing must be done during daylight.

Joints bars should be dipped or painted with heavy oil instead of tar or asphalt.

In reinforced pavements the steel will be placed 2½ ins. from top surface instead of 2 ins. The maximum width of fabric sheets will be 9 ft. instead of 6 ft.

A tinker tamp will be used to precede the steel screed to secure greater density of concrete around the steel. This will make a total of two tinker tamps and one steel screed for reinforced concrete roadways.

Natural rock asphalt will be laid to a prescribed thickness of 1½ ins. instead of 2 ins. and the concrete base course for this will be 5½ ins. thick instead of 5 ins. The maximum size of stone for penetration macadam will be 2¾ ins. instead of 2½ ins.

Vitrified pipe will be triple strength instead of double. Cast iron pipe may be either smooth or corrugated.

Concrete pipe will be tested for 1,000 lbs. by the three-point bearing method instead of 1,500 lbs. The requirements per mix of concrete and curing are omitted but the pipe must pass the strength and absorption tests.

Every successful engineer as well as any other professional or business man realizes that he must keep his work up to the best current practice; for this reason specifications should be studied and revised annually.

Work and policies must be carefully watched throughout the construction period, and any desirable changes should then be included in the annual revision.

The old saying that we should never abandon a policy or method simply because it is old or change to new methods simply because they are new, applies to construction and specifications. We must know why we do things in order to perform intelligently.

The foregoing article by Mr. Conner is reprinted from the North Carolina Highway Bulletin for March, 1923.

SELECTING ENGINEERS FOR CITY SERVICE IN PHILADELPHIA

By Charles S. Shaughnessy, Chief Examiner, Civil Service Commission, Philadelphia, Pa.

Our treatment of the subject of examinations will be confined to the problems of administration of the Examination Bureau of Philadelphia and how we endeavor to meet them. These problems are common to all services, including the engineering and, therefore, the points discussed will be more or less general. Then there are other human problems that come to us of which we cannot give an account inasmuch as they have to do with a great variety of special and individual conditions. It is one thing to have a civil service law and quite another to carry that law into practical effect so that we shall have honesty and fairness in examinations and complete success in the scope of selection.

The problem of selecting persons for the public service is very difficult and intricate and to the casual observer who reads about civil service in the papers the selection at times may appear to leave much to be desired. It must be borne in mind, however, that the difficulties are not inherent in the employment problem but rather due to the political conditions under which we live. The value of the Merit System does not show up in individual cases but rather reflects itself in the general level of intelligence and morale of the entire service. Being of slow and steady growth, its great and lasting benefit reflects itself in a growing improvement in the service. We say that it does not show up in individual cases because we are all prone to decide things on individual cases rather than through the abstract or impersonal effect.

Those who are close to the civil service problems realize perhaps more than anybody else that there are certain latent possibilities in men that cannot be decided in a civil service examination, nor in any examination. Capabilities of men sometimes are not discovered until these men are given the work and the responsibility. Even their superiors at times do not make such discovery until they have been given a try out and an opportunity to make good on the job. Similarly, there are certain defects in a great number of people which do not appear until they have been put in charge of others. The civil service examination, which is well planned and rated, with due regard to the position to be filled, is the best instrument of human measurement yet devised—but like all instruments operated by human beings, it lays no claim to perfection. The City of Philadelphia has the greatest opportunity of any city in the country to test the truth of this statement. Here we have side by side 17,000 employees under the Merit System and 3,000 in the County Offices.

Some day we hope that a study will be made showing the comparative intelligence and productive capacity of these two groups of people. We feel certain that the results will show decidedly in favor of the Merit System.

The procedure of examinations must follow the mandate of law just as does any instrument of government. We must function in accordance with the powers vested in us by the City Charter and with the facilities given us by our budget. Being a problem in human engineering it is not unlike the way of the engineer in letting contracts by competitive bidding. Where the engineer wishes to measure the quality of any material such as sand, he takes samples from various parts of the bank, then mixes and quarters them so that there may be a resulting sample which is composite and representative. Likewise in civil service we sample a person from various angles, his past achievement, his practical knowledge and his personality.

The Problem of Staff

We have three permanent examiners including the Chief Examiner and three part time examiners. With the great amount of work we have to handle it is obvious that this staff must be augmented in some way or other. We are obliged to call in outsiders, special examiners who give of their time gratuitously, in the line of work for which the examination is held. These special or honorary examiners are continually changing, on every monthly schedule; some are new and some serve occasionally. Conceive, if you will, the problem of establishing and maintaining uniform and equitable standards for examinations for over three hundred different kinds of positions with a continually changing staff. You can readily see the problem that is put before our examiners in instructing new people in the work, for as we all know it is a specialty of its own. To place the matter on an engineering basis, let us assume that you have an important piece of design or construction to do and find that your force is continually changing. This adds to the magnitude of the work, especially if the turn-over is high. This is one of the most serious problems we have in Philadelphia and I am sure every engineer can appreciate it. While special or honorary examiners are important and necessary—in fact they are an essential part of the Merit System—their number is out of proportion to the permanent staff.

Plan and Development of Examinations

Examinations are means to a certain end. They are not regarded as a matter of routine but rather one of growth and development. We are correlating and modifying them at all times in order to make them correspond to the positions to be filled. To this end we confer with departments, inspect the character of the duties, study the various fields of activity which best fit for this line of work and make a complete job analysis. We are then ready to lay down the subjects and weights so that the competitors possessing the required capabilities will come to the front rank. In order to keep the matter up to date and to make improvements from time to time we review the plan periodically and study the results of the last examination. This procedure if consistently followed will show vast improvement in the course of a few years. There are several classes of tests, experience, practical questions, etc., that are judiciously arranged to secure the real order of merit.

Training and Experience

The subject of Training and Experience is a statement of training with a chronology of assignments in private employment. On account of the concealment of identity we are not able to determine the quality of service until the actual ratings are made up. This makes the question of evaluation very difficult. Add to this the tendency of some candidates to exaggerate and you have some idea of the magnitude of the problem. However, an experienced and discerning examiner can select the salient features of a candidate's statement and can separate the "wheat from the chaff" with a surprising degree of completeness and comparative accuracy. That we need other tests to supplement this is shown by the fact that sometimes a candidate with high experience has very little knowledge of the position he is seeking; thus demonstrating that he did not profit as much by his experience as was expected nor as much as his competitors.

The Written Examination

The written examination determines knowledge and intelligence and gives a record in case there is need for review. It must be realized that the formulating of questions based upon duties of positions is a faculty in itself. Laying down questions which can be readily understood and have but one meaning is a very difficult task. To appreciate this one has

only to attend one of our examinations and listen to the questions that are put to the examiners. But the real problem in connection with the written examination is the rating of the questions—picking out the meaning of the candidate, reading between the lines and giving him a fair credit for his effort. Any form of test which involves language is somewhat subject to error on account of the fact that it is difficult to discriminate between facility of expression and knowledge of the subject. Mere verbosity as in ordinary life may pass for intelligence or knowledge. Here again the experienced examiner is able to get to the meat of the matter and evaluate the written word exceptionally well. We feel that, by and large, and taking into consideration the entire examination, even those handicapped by the use of language attain their proper place in order of merit.

The Practical Test

The engineer who is essentially a practical man appreciates the practical demonstration as a test of ability. We endeavor to hold a practical test for all the skilled trades. The last examination we had for Auto Truck Drivers consumed the greater part of two weeks. The carpenters and plumbers examination similarly took a great deal of time. We have been obliged to forego a great number of practical tests which we feel are necessary owing to our inability to conduct them because of lack of force. But we feel this test to be the most accurate of any subject yet used in examinations. It lends itself to comparative evaluation and is a positive instrument of proven worth through a specified task on the job.

The Personal Fitncss Test

The object of the personal fitness test is to secure some measure of personality. It is extremely important in some positions, especially those of an administrative character or those having to do with the public. Properly to conduct the personal fitness test requires persons of good common-sense; a keen insight into the human quality; and a judicious and discriminating mind. Standards can be developed under these conditions, which with an examining board of three persons, gives a good comparative measure of the personal equation. We are finding this test an efficient supplement to the other subjects of the examination.

Present-Day Needs

There is unmistakable evidence of the great value of improved methods in civil service examinations in raising the level of intelligence of city employees. Translated into positive action this insures to the taxpayer, and all the people, an increasing measure of real service which means much to government. That the progress already made may be conserved and further accelerated there are three desiderata:

1. A closer mutual interest among the departments and the Civil Service Commission in solving personnel problems. A spirit of cooperation which regards civil service as a constructive agency, aiding each department to fulfill its functions more effectively.
2. All personal service budgets of departments to have titles which shall be descriptive and appropriate to the duties to be performed. Thus a title of a position shall mean a definite duty; and when a requisition is made on the Commission for men to perform such duty there shall be no possibility of misunderstanding.
3. An increase in the Examining staff of the Commission.

The foregoing address was presented by Mr. Shaughnessy before the Society of Municipal Engineers of the City of Philadelphia on January 19, 1923.

COMPARATIVE GASOLINE CONSUMPTION ON DIFFERENT ROAD SURFACES

By A. B. Cutter, City Engineer, Everett, Washington.

Having noticed more or less conflicting reports as to relative tractive resistance of rigid and non-rigid and gravel types of road surface, I arranged during the past winter for the making of exhaustive tests in the State of Washington, which is my home, and the neighboring States of Oregon and California, and believe the result will be of public interest. There being no snow in the Pacific Coast States, the test could be made during the winter months.

Types Tested

Representing the three general types of road surfaces, sections of road were selected for each type as follows:

1. Rigid type—Portland Cement Concrete.
2. Non-rigid type—Warrenite Bitulithic.
3. Gravel or earth.

The rules governing the comparative tests were as follows:

(a) Distance of each test 100 miles continuous operation. This was regarded as a distance sufficient accurately to record the gasoline consumption and produce a fair average. In some previously reported tests the mileages have been so small and so variable as to provide grave danger of inaccuracy.

(b) Make test on road surfaces in good condition but having had at least three years' practical use.

(c) In each State use the same automobile for comparative test of the several types, but different machines were used for comparative tests in some of the states.

(d) Uniform speed of not less than 20 nor more than 30 miles per hour.

(e) Record the date, location, speed and gasoline consumption on exactly 100 miles, as shown by speedometer on the car.

It was not practicable to here make test on gravel road, but exhaustive tests on the other surfaces were as follows:

Washington

Road Surfaces	Bitulithic	Portland Cement Concrete
Date of Test	February 7, 1923	February 8, 1923.
Location	Pierce County, Pacific Highway from DuPont to Country Club	Mountain Road, being extension of Pacific Highway toward Ranier National Park
Air Temperature	40 to 50 deg. F.	40 to 50 deg. F.
Tire Inflation	60 lbs. rear, 55 lbs. front.	60 lbs. rear, 55 lbs. front
Running time 100m.	3 hrs. 45 mins.	3 hrs. 45 mins.
Average speed per hr.	26.7 miles	26.7 miles
Gasoline consumed	5.5 gallons.	5.5 gallons.
Miles per gal. gasoline	18.2	18.2

Oregon

Road Surfaces	Bitulithic	Portland Cement Concrete	Gravel
Location	Base Line Road Columbia River Highway	Multnomah Hillsboro Road	Multnomah County East of Portland
Date	Jan. 25, 1923	Jan. 30, 1923	Jan. 31, 1923
Weather	cool-moderate wind	cool-moderate wind	cool and fair
Tire Inflation	60 lbs. rear, 55 lbs. front	60 lbs. r., 55 lbs. f.	60 lbs. r., 55 lbs. f.
Running time 100 m.	4 hrs. 35 mins.	4 hrs. 25 mins.	4 hrs. 40 mins.
Average speed per hr.	21.9 miles	22.7 miles	21.4 miles
Gasoline consumed	5.25 gals.	5.5 gals.	7.0 gals.
Miles per gal. gasoline	19.05	18.18	14.28

California

Road Surfaces	Warrenite-Bitulithic	Portland Cement Concrete	Gravel
Location	Tulare County	Tulare County	Fresno-Raisin Rd.
Date	Feb. 3, 1923	Feb. 3, 1923	Feb. 1, 1923
Speed	15 to 20 m. pr. hr.	15 to 20 m. pr. hr.	15 to 20 m. pr. hr.
Weather	Fair	Fair	Fair
Temperature	45 to 75 deg. F.	45 to 75 deg. F.	55 to 70 deg. F.
Gasoline consumption 100 miles	7.1 gals.	7 gals.	7.8 gals.
Miles per gal. gasoline	14.08	14.28	12.95

Conclusions

The above tests show that:

(a) Between Portland Cement Concrete and Warrenite-Bitulithic roads tested under uniform conditions, there is practically no difference in gasoline consumption.

(b) On gravel or macadam roads in good condition, the gasoline consumption is from 10% to 35% greater than on either Warrenite-Bitulithic or Portland Cement Concrete road surfaces.

(c) The tests were made on road suffaces in good condition. Of course the gasoline consumption would be relatively increased if the road surfaces were in bad condition.

(d) Under modern volume of traffic, good roads rapidly pay for themselves in economy of gasoline consumption and the same holds true in economy of tire and other automobile wear and tear. For instance, given a road carrying an average of 2000 vehicles per day or 730,000 vehicles per year, and calculating from the Oregon test above, we find with all the road surfaces in good condition, that:

On Warrenite-Bitulithic and Portland Cement Concrete roads the gasoline consumption is about 730,000 divided by 19 equals 38,400 gals. which at 30c equals $11,520 worth of gasoline, the consumption per mile of road per annum.

On Gravel roads 730,000 divided by 14 equals 52,000 gals. which at 30c equals $15,600 worth of gasoline the consump-

tion per mile of road per annum.

Saving on gasoline above by hard surface roads is 13,600 gals. at 30c equals $4,080 per mile of road per annum.

2. The relative saving in wear and tear on tires and other automobile parts cannot be computed, but it doubtless is fully as great as the gasoline consumption. Add to this the savings in road maintenance cost (to say nothing of wear and tear on nerves of road users) we have an object lesson of the economy of high type roads and of keeping roads in good repair for economic use.

THE DEVELOPMENT OF HIGHWAY TRANSPORTATION

By H. W. Howard, General Motors Truck Co., Pontiac, Mich.

In studying transportation we quickly discover that it influences every phase of our existence. The transportation of goods is an absolutely essential requirement for the family, industrial and commercial life of a civilized people.

Transportation Slow to Develop

As a background, I should like to draw a rapid picture of transportation development. Strange as it may seem, nothing in the world has been so slothful in its development as transportation.

Ninety per cent of all the years that have elapsed since the birth of Christ saw in use the same primitive mediums of transportation that prevailed during His lifetime.

In 1800 years the world had not advanced beyond the point of the man-hauled or the beast-hauled wagon or cart, or the man-propelled or wind-propelled boat.

The Evolution of Trade Carriers

The idea of a boat as a carrier came early in history. The very earliest known human beings fastened logs together and guided them down stream, or even scooped out one side of a fallen tree and made a rough canoe in which they carried their belongings. If they went by land, however, their method for centuries was to shoulder their loads pickaback. If two men were together they learned that the burden could be carried more easily if it were suspended from a pole whose ends were supported on their shoulders. Thus the lever principle was used in many forms of carrying devices. In due time, perhaps as early as 3000 B. C., man learned to make the wheel which served as a burden-bearing device. It was but a short step, then, to the two-wheeled carts and chariots to which the merchants and warriors of ancient Babylon harnessed their oxen or donkeys.

The Horse Supplants the Ox

A thousand years later, or perhaps more, the mountaineers came down into Babylon leading a strange animal which the Babylonians had never seen. This beast proved so amenable to training, so strong and so fleet, that he began to supplant the slower and more cumbersome ox as a beast of burden. Thus the horse first appeared in a civilized community to play the important part he has maintained ever since in the commerce of the world. From that time to this, he has been regarded as the standard by which other units of transportation are judged.

And Finally the Horseless Vehicle

With the advance of civilization and the discovery of such forces as steam and electricity, remote communities became connected with each other by means of steamships and railways, so that trade and commerce grew to tremendous proportions.

For years the horse and wagon supplemented the steamship and railway, but with the advent of the gasoline engine, the horseless wagon made its appearance and has steadily increased in favor for commercial haulage because it has proved to be stronger, faster and more economical than the horse and wagon.

Transportation by motor truck lies entirely within the 20th century. While the railroads have been building since the fifties and have taken over half a century to acquire their present proportions, the first motor truck was built as late as 1900.

I should like to illustrate by figures relating to 1921, just how freight haulage by motor transport compares with that carried by steam railroads, (1922 figures are not yet complete):

Railroads carried 1,642,251,000 tons of freight.

Motor trucks carried 1,430,000,000 tons or 87% as much as the railroads; truly a remarkable showing.

Someone has well said that "the future development of any type of transportation will be governed by the economic value which it will be able to show the communities it serves."

The past few years have witnessed an economic shift greatly favoring Motor Transport. The field for Motor Transport has consistently widened.

Railway officials have readily admitted

that for intra-city movement and for inter-suburban service Motor Transport fills a much needed gap, handling less-than-car-lot business more efficiently and economically.

Mr. Gerrit Fort, Vice-President of the Boston and Main Railroads, has stated, "the motor truck has come to stay. It represents an economic change in transportation conditions which is little short of revolutionary. There is no use in fighting the motor truck. Within their own field the trucks are unbeatable."

We do not think that we can take the place of the steam railway in long distance hauls. We do not think we can move freight as cheaply as the waterways. We concede cheerfully the function of other mediums, but we do insist that our place be equally recognized.

Motor Vehicles Feeders to Railroads

The motor bus, the truck, and the passenger car, have temporarily taken some traffic from the railroads and trolleys, but isn't it true that they have been feeders which helped to increase traffic as a whole? Much produce would never reach the market if it were not for trucks to bring it to the railroad station, while scores of people now travel on trains who seldom left home prior to the general introduction of the automobile.

The truck is daily proving its own case. Its increasing use would not be possible if it were not efficient. Whether the truck be placed at work in the city on short or long hauls or in suburban or inter-city work it will usually show a decided saving over the horse-drawn vehicle. There are cases, of course, where the horse should still be used. This is a question to be decided upon on a dollars and cents basis and should be considered by a competent Transportation Engineer. The cause of some dissatisfaction with trucks in the past has been inefficient operation and cost keeping. I will discuss this point a little farther along.

Looking at the motor truck in a broad way it possesses the following important advantages over horse-drawn equipment:

First: Speed.

Second: Increased Power.

Third: Adaptability to difficult work.

Fourth: Regularity of service.

Fifth: Greater effective delivery range.

Sixth: Publicity value.

I could spend a great deal of time enlarging upon these points but I think that these advantages are familiar to all.

How the Farmer Benefits

It is not the city man or his family which benefits most from the motor truck. The farmer is typical of one who gets the greatest benefits. When joined with good roads, the motor truck: Gives access to the nearby town and thus ends his isolation; it enables his children to go to better schools, (bus lines are now operating that take school children to more than 12,000 schools of a much better type than the one-room school house of old: It gives him more time to work on the farm; the land he buys can be bought for productivity irrespective of whether or not it is near a railroad; it brings supplies of all kinds to his door, including the daily paper and the magazines. It is his connecting link with his market and permits him to move his produce when prices are right.

The truck-using corporations form but an infinitesimal part of those who gain from motor transportation.

Why Shippers Prefer Trucks

We find very generally that, aside from the rates, the reasons why shippers prefer motor trucks include: Own control of the shipment; no boxing; door-to-door delivery; regularity of delivery and operation of plants; saving of time; permit carrying lighter stocks with saving in interest.

The truck may have temporarily taken some traffic from the railroads, but in return it has given them a lot of traffic which otherwise might not have been available. Prominent railroad men ask that the truck take the short haul business, which to them has been unprofitable because of congested terminal facilities.

The truck undoubtedly takes traffic from some short haul railroads. Of the 649 railroads in the short line association, more than two-thirds are listed as having less than 25 miles of track, which, under the new order of things, means that they will have difficulty competing with the motor truck and are, to some extent, an economic waste.

Railroads Using Motor Buses

We find, too, that instead of extending and building branch lines, railroads, trolleys, and even the Chicago "L" road, are making use of motor buses as feeders. President Harding in his last message said: "The motor truck should become a co-ordinate factor in our great distributing system."

Vice-President Lee, of the Pennsylvania, says many bus and truck lines have failed. Undoubtedly many lines were

started over routes where profits were not possible, while many others with good prospects were ruined by mismanagement, operating costs and inefficient operation. And yet hasn't that same thing been true of many of our railroads in past years?

The shipper is interested not alone in railroad or truck transportation, but in complete transportation. He must examine his total costs, not that portion which goes to one carrier. It is the public duty of all agencies of transportation so to co-ordinate their facilities as to give the public the best possible service at the lowest possible cost.

Can Save by Re-organizing L. C. L. Business

From 20 to 25 per cent of the total railroad equipment is absorbed in the carriage of less than 5 per cent of the business and less than 10 per cent of the carriers' earnings comes from this source: less-than-carload freight.

Fifty per cent of the capital investment of the rails is tied up in other than main line facilities. Is it not the duty, then, of the transportation agencies to examine their less-than-carload freight business and to make changes in practice which will cut down their operating expenditure while increasing their net income?

Railroad men generally agree that the short haul field is unprofitable in most cases and belongs properly to the motor truck. The door-delivery service, the terminal and intra-yard use and the service of generating of new business for the rail lines indicate the real sphere of use of the motor truck.

The fields within which complete transportation of goods can be furnished by highway alone or by railway alone are limited. Let me explain that complete transportation covers the moving of the goods all the way from the premises of the shipper to the premises of the consignee.

Trucking Distance 25 to 150 Miles

There are very few industries or residences in the continental United States, which are not connected with each other by highway and it is physically possible to perform complete transportation of goods by highway, between almost any two industries or residences. But such transportation is most economical only when limited to the movement of goods between homes or industries which are within reasonable trucking distance from each other. The determination of such reasonable distance depends on many conditions and a competent truck expert will place it anywhere between 25 and 150 miles. Of course, there are emergencies and peculiar industrial conditions which, in rare cases, make trucking economical over a distance of several hundred miles, but such cases are negligible in the consideration of the whole field of highway transportation.

On the other hand, comparatively few industries and practically no residences are connected with each other by railway. Therefore the field for complete transportation of goods by railway is restricted to the movement of car-load freight between those industries which have direct rail connections.

In view of this situation it is inevitable that there will be an increased common carrier use of the truck. In these cases franchises should be granted and the carriers required to operate on fixed schedules over definite routes. Since any charge against transportation is a charge against the consumer, we do not believe in transportation taxes, but we do not ask that other agencies be taxed and we exempt. All we demand is that there shall be no discrimination in taxes against any unit in completed transportation.

Some people like to say, tax the motor truck operator. He gets the benefit. Did you ever know anyone who drove a motor truck for pleasure? He drives because the consuming public demands the service.

Occasionally we hear a complaint from a railroad official that it is unfair to build roads alongside of railroad tracks because they put highway transportation in direct competition with the railroads, which in turn have to pay part of the cost of construction of the highway. That seems a reasonable basis for a complaint until we begin to analyze the question.

Railroads Paralleled Highways

It should not be overlooked that the railroads were the first to parallel our highways. Later the trolley lines paralleled the railroads, and now public demand requires the improvement of the highway to care for increasing travel.

The highways thus improved are intercity roads over which there is ten times as much passenger travel as truck travel. These car owners are probably the biggest payers of taxes in that vicinity.

A major part of the trucks using it are owned by business men or corporations in that vicinity, who have contributed

heavily in taxes for the building of the highways.

Much of the travel on those highways are with trucks and buses bringing merchandise and people to railroad stations for long haul travel.

Community Requires Intercity Roads

These intercity roads are required by the community. Light feeder roads are built back into the agricultural sections, all leading to the main highways and the big towns where the markets are located. These big towns are naturally connected up by the highways the same as they are by railways. The rail lines undoubtedly lose some traffic, but in the long run their gains far outweigh their losses.

Congress, in its last federal appropriation for highways, provided to some degree for the upkeep of these main traveled lines used by everybody in the state, and even by those out of the state.

I have mentioned the necessity for efficient operation and cost-keeping covering motor truck equipment. Motor trucks are wage earners. They prove the right to consideration in our transportation by the extent of the economy which they effect. Whether to use motor trucks or not must be determined upon a dollars and cents basis.

Bear in mind that the cost of operation per day, of the unit, does not tell the whole story. The work capacity of the unit involved is even more important. That is, how much work will the respective units perform per day? It all must be brought down to a cost per ton mile basis in order to obtain a comparison. Even with the cost per ton mile at hand you will not have the true answer unless you are sure your equipment is being operated efficiently. I will discuss this point a little later.

It is only in recent years that proper attention has been given to the question of securing the real cost of operating delivery equipment. We know fairly well what it costs to operate gasoline trucks, but without question there is still room for improvement in this direction. Without a standard cost system, comparative figures will not mean much. Unless costs are figured on the same basis and in the same manner a comparison of these figures will cause endless confusion and argument. I recommend to you the adoption of a standard set of forms in compiling your delivery costs covering both motor trucks and horses and other delivery equipment. By using a standard method, a comparison of cost figures would mean something and if one member found his cost above the average, he could quickly find out why and endeavor to correct the situation.

The Truck Owners Conference, Inc., have formulated a National Standard truck cost system. Their first effort resulted in such a complicated system that it was not practical in many cases. They have a simplified form, however, which is proving to be very popular and at the same time tells the truck operator what he should know about his operating costs.

Let us consider for a moment the subject of efficient operation of delivery equipment. The amount of work that a truck can perform depends largely upon the efficiency with which it is handled.

I wonder how many truck operators realize the importance of the lost time factor and what it is costing them every day? How many traffic managers in control of trucks have set out to study first hand what is a satisfactory day's work for a truck? How many traffic managers have ridden all day on delivery vehicles, making time studies of the vehicle, the driver and the helper, during the work day?

The question of the lost time factor is worthy of our earnest consideration. The lost time factor usually contributes more toward the operating cost of motor trucks than do the items of depreciation, repairs, gasoline, etc., put together.

In a general way, most progressive truck operators have realized this. They will tell you that "it doesn't pay to have a truck stand around doing nothing," and they seek in probably a halfhearted way to keep their trucks moving.

But if the prime importance of this lost time factor was fully understood by motor truck owners and if it were recognized what enormous savings or earnings could be effected in transportation costs by reducing this factor to the absolute minimum, the demand for motor trucks would be so great as to swamp the manufacturers completely.

How shall we arrive at the lost time factor? The best way is to make a time study of the truck's operation. An analysis of the time during which the truck is not in motion will quickly show why the truck is not earning more money. This unproductive time should then be cut down to the very minimum by endeavoring to improve the loading and unloading conditions as well as eliminating other delays which are made apparent by the time study. This will permit the opera-

tor to arrive at a standard trip time against which the daily record of operation should be checked

As a basis for comparison of trips a standard should be established covering the following items:

1. Minimum loading time.
2. Minimum unloading time.
3. Running time per mile.
4. Average loss of time on account of poor drivers, traffic delays, etc.

Such standards should be established for various lengths of haul. This gives an exact basis for figuring the time required for any length of trip. A definition of a day's work should be conceived by the traffic manager at his office, but determined by studies of actual conditions in the field.

In the short time available for the discussion of such a large and important subject, I could only hope to touch upon a few of the high spots. I will feel well repaid if I have impressed upon you the value of making a real analysis of your transportation problems. The adoption of a standard cost system would be well worth careful consideration. I can summarize my message in two short sentences.

Be sure your delivery costs are accurate. Make sure you are operating your delivery equipment efficiently.

The foregoing paper by Mr. Howard was presented at the Annual Convention of the Allied Motor Commerce (of Ind.) at Indianapolis, April 30, 1923.

SALVAGE AND MAINTENANCE OF MACADAM ROADS IN PENNSYLVANIA

By W. A. Van Duzer, Assistant Maintenance Engineer, Pennsylvania State Highway Department, Harrisburg, Pa.

The development of road construction and the necessity for intensive maintenance is directly attributable to the increased motorization of traffic. The problem now confronting highway engineers, and which has confronted them for the past decade, is to keep pace with this increase.

As an example, motor vehicle registrations in Pennsylvania in 1912, both automobiles and trucks, totaled 58,221. In 1922 there were registered 765,000 automobiles and 66,000 trucks, or a total of 831,000 vehicles.

The funds actually expended in the maintenance of the highway system in 1912 totaled $900,000, while the expenditures in 1922 totaled $8,770,000. That is, in 1912 we had available for maintenance $15.46 for each automobile and truck registered, whereas in 1922, although there was increased travel on the roads and a very great increase in the weight and use of trucks, we had but $10.55 for each vehicle registered. This in face of the fact that our mileage has been increased in the last ten years by 1,520 miles, making a total of 10,320 miles.

The finances available for road construction have of necessity limited the building of durable types of pavement, and therefore road authorities, who have the comfort of the traveling public at heart, are applying modern methods of maintenance to some of the older types of construction, with varying degrees of success.

The Problem

The problem in Pennsylvania has not differed to any extent from that in other states, except that the stone road mileage is greater on account of the large number of toll roads that were included in the original highway system. By legislative enactment, approved May 31, 1911, 8,800 miles of highways in Pennsylvania were taken over for construction and maintenance at the entire cost of the state. Of this 8,800 miles, 521 were toll roads built by various corporations during the past century, and in the main were of the macadam type of construction. The mileage of other macadam roads totaled 2,100.

The majority of the toll roads and a great many of the other roads acquired in 1911 were very narrow, in some instances not over 12 ft. in width. There was a woeful lack of both sub-surface and surface drainage. A comprehensive survey of the condition of the roads was made in 1915 and a definite policy established with regard to a program of resurfacing and reconstruction. It was felt that if the state was to have a connected system of highways a certain amount of resurfacing of the old stone roads should be taken up each year, and the demands of traffic compelled the department to find some methods of resurfacing, in addition to the water-bound macadam or penetration types. It was early shown that our finances would not permit the resurfacing of sufficient mileage with either of these types to give the required results in the desired time. It was, therefore, determined to use the water-bound and bituminous macadam upon the heavier traveled routes,

while the unbound macadam, which will be fully explained later on, is used upon the secondary or less traveled roads.

Organization

In order properly to carry on the maintenance work and to provide for the increase, which would surely develop, a modern organization was established which places the responsibility for the maintenance of these roads upon 15 District Engineers, reporting to the Maintenance Engineer, and 53 Superintendents, working under the direction of the District Engineers. Under the Superintendents are foremen, caretakers, laborers, etc.

Planning

We have always given a great deal of attention to the proper planning and outlining of our maintenance work, which consist chiefly of the reclamation of stone roads. Systematic and thorough surveys of local materials have been made in all parts of the state and tests taken to establish their relative values. When it is impossible to obtain local material, quotations are secured from commercial quarries and the stone is shipped in. Wherever possible mechanical means of unloading material have been adopted.

Traffic Census

A careful and accurate traffic census was early inaugurated, which has been of considerable assistance in determining the type of repairs. It has been our experience that the proper surfacing of a road will create a traffic out of all proportion to the seeming importance of the roadway.

Equipment

At the beginning of the year a thorough study is made of the total amount of work in each district and the necessary equipment required, such as rollers, trucks, etc., after which a schedule is made up for each job, showing the length of time that the equipment will be in operation upon each specific authorization. By this method we have kept our department equipment operating continuously, thereby reducing to a minimum the necessity of renting machinery.

Base Survey

Before the actual operation of water-bound macadam or bituminous macadam resurfacing is taken up, we establish by actual measurements the depth of stone in the existing roadway. In places where water breakers are found they are removed. Test pits are excavated to the bottom of the stone in the center, and measurements are taken on each side for a distance of half the width of the road. These pits are dug every 25 to 50 ft., depending upon the type of the road. After this work is completed the base is widened out, and in places where sufficient foundation is not shown additional stone is added to bring it up to the required depth. Then the road is scarified lightly and reshaped with a road machine. The base is brought to a true cross section and grade by the use of a crown board and steel pins are driven every 10 to 20 ft., depending upon the profile, and a cord stretched along the edge and to the top of the proposed ballast. Berms about 4 ft. in width and from 1 in. to 2 ins. above the line are then built up.

Water-Bound Resurfacing

Our experience has shown that more satisfactory results are obtained by the use of large stone for water-bound macadam resurfacing; that is, stone varying in size from 1½ ins. to 3½ ins. The material is dumped upon the subgrade and forked, thus eliminating the danger of the segregation of the sizes, which is the cause of a great deal of subsequent patching. The stone is built to a crown board and then thoroughly locked with the roller, after which the screenings are applied fanwise with a shovel and rolled until the voids are thoroughly filled. The water is then applied and the road rolled until the mortar is flushed or puddled, and the road is then allowed to set before surface treatment.

The maintenance of the road during the time that it is setting consists principally of sweeping, either by caretakers or lightly by mechanical brooms or horse-drawn sweepers. The sweeping is done for a dual purpose: First, to remove the caked or matted screenings from the edges, which must be done in order that proper penetration of the surface treatment material may be obtained, and, second, to replace these screenings in the center of the highway from which they have been removed by the action of traffic, which will prevent the road from raveling and assist in compacting it. Under especially heavy traffic it is found necessary to add screenings, and during hot, dry weather horse-drawn sprinklers can be used to advantage.

Surface Treatment

Previous to the first application of the bituminous material, which we believe should give the maximum penetration, the screenings must be removed by sweep-

ing so that the voids will show between the ballast to a depth of possibly a quarter of an inch. Material must be applied in two applications with a pressure distributor, the first one to be approximately 0.33 gal. to a square yard, and the second from 0.20 to 0.25 gal., as the road requires. It has been shown in some cases that a third of a gallon applied will penetrate the road from a quarter to five-eighths of an inch, this penetration depending upon the kind and cementing value of the stone. The second application will heal up the spots that are not thoroughly bonded, but will not fill the voids, and leaves the ballast to take the voids with the bituminous material as a binder. Although we do not ordinarily apply chips upon the first treatment, skid chipping is desirable as a safety measure on heavily traveled roads by applying from 5 to 10 lbs. of chips to the square yard.

In order to obtain the best results, our experience has been that three successive treatments should be made; that is, the first year the treatment described above, and providing the road is subjected to extremely heavy traffic, a second treatment is given the same year, and the third the season following.

The second treatment should be a high viscosity bituminous material, the quantity just sufficient properly to fill the voids, and this can only be determined by experience, but in most instances varies from 0.25 to 0.30 of a gal. per square yard.

Hard stone chips, ranging from ¼ in. to 1 in. in size, dustless and free from dirt, should be used as a covering at the rate of from 20 to 30 lbs. per sq. yd., or approximately 1 cu. ft. of stone chips to 1 gal. of bituminous material.

Owing to the large chips used and to assist in compressing them into the bitumen, the treatment should be rolled with either a 5 to 8-ton tandem or a 10-ton macadam roller, as soon as the chipping is completed, but if a material that does not dry rapidly is used, we believe that equally good results can be obtained if the road is rolled from 24 to 36 hours after the bituminous application.

The third treatment may be either a high viscosity coal tar, water gas tar or asphalt, or, as an alternative, a hot material. We apply from 0.15 to 0.25 gal. per sq. yd. of the hot material, which requires from 30 to 40 lbs. of chips. This treatment must be watched carefully, as the road will bleed after being thrown open to travel, and if not given proper care will pick up under tire wagon traffic. I have known instances where a treatment of this character applied late in the fall required re-chipping at the beginning of the hot weather in the spring. We have found that stone chips for covering give the best results.

Bituminous Macadam Resurfacing

The reclamation of the old base for bituminous macadam resurfacing is taken up practically in the same manner as the water-bound. After the road has been brought to a true cross section, approximately 3 ins. of stone, varying in size from 1½ to 2¾ ins., is spread to a depth of 3 ins. This is locked by rollers and then the bituminous material is applied at the rate of 1¾ to 2 gals. per sq. yd., depending upon the kind of material used. Stone is uniformly spread, varying in size from ⅝ to 1 in., which is properly rolled and a seal coat of from ½ to ¾ gal. per sq. yd. of bitumen is then applied and chips of approximately ½ in. are spread over the surface. The road is then rolled until it is properly bonded.

In some instances we have prepared a base, employing practically the methods of water-bound macadam construction, even to the extent of an application of bituminous surface treatment of a material giving the maximum penetration; placing on the base so prepared a hot mix of either sheet asphalt or asphaltic concrete.

Unbound Macadam

The unbound macadam, which we have used with good results on secondary roads, is considerably cheaper than the water-bound construction, and for one or two seasons gives very satisfactory results. The method usually employed in the construction of unbound macadam is to scarify the old road surface, shaping it up with the road machine and rolling until a firm foundation has been obtained. Stone, clear of dust, varying in size from ½ in. to 1½ ins., is piled along the side of the road. Just ahead of the distributor the stone is spread uniformly to a depth of approximately 2 ins. Where possible traffic is kept off, or at least confined to one side. Then apply from 1/3 to 2/3 gal. per sq. yd. of bituminous material, with the proper penetration, or a larger amount where two applications are made, which is governed by the depth of the loose stone and is varied accordingly. The material is allowed to dry for from one to three days and then rolled, and providing

a larger amount is required properly to seal the road, apply 0.20 gal. per sq. yd. Under traffic it becomes comparatively smooth and little difficulty is experinced through rutting.

Maintenance System

We know of no type of construction that requires more uniform and continous maintenance than stone roads. The advantage of thoroughly experienced workmen is unquestionable; care must be exercised in picking the organization and seeing that proper instructions are issued covering each phase of the work.

There are two general systems in vogue in the maintenance of these roads, both of which have their advantages. First, the caretakers or patrolmen, the other the patrol crew or gang. The first, of course, comes closer to the ideal if properly controlled. This plan arranges the road mileage in sections three to five miles in length, each section in charge of a patrolman provided with the necessary tools, materials, etc., whose duty it is to take care of the small repairs and emergency work and with authority, when necessity demands it, to hire additional men, teams, etc., upon instructions from his immediate superior. These caretakers keep the surface patched, all depressions filled, see that the side gutters and cross drains are kept open, and paint slight surface depressions and sprinkle with chips tamped in place. Larger depressions are filled with large stone and then topped with patching tar and chips, the mix varying in proportion of 1 to 12 or 1 to 15, depending to some extent upon the weather. The patrolmen or caretakers file daily report cards, giving the character and extent of their work, hours engaged and nature of work performed.

The patrol gang is an organization of picked men, provided with tools, material, etc., to maintain various lengths of road mileage. It is probably more economical than the caretaker system, the men being well trained for each class of repair work. The difficulty experienced in this kind of maintenance, however, is that it is impossible for a force of this character to give each section the required attention at the proper time, especially in emergencases. The particular advantage of the gang system is an insurance against shortage of labor, especially on those sections of road lying in sparsely populated districts. The control can be taken care of by operation reports.

The success of stone road maintenance depends upon organization, equipment and material, a thorough knowledge of conditions and a desire, from the executives to the humblest workmen, to give real road service.

The foregoing paper was presented at the recent annual meeting of the American Road Builders' Association.

DEVELOPMENTS IN CONCRETE PAVEMENT DESIGN IN IOWA COUNTIES

By Raymond Zack, District Engineer, Iowa State Highway Commission, M. B. A. Bldg., Mason City, Iowa.

In discussing a topic of this character I must perforce confine myself solely to concrete paving, because my paving experience has been largely limited to that type alone and for the same reason this discussion must be restricted to county highway paving. A discussion of city types is a large subject in itself and should be handled by men who have specialized in that class of work.

Every succeeding year since the first concrete pavement was laid in Iowa has seen changes in the design, and in the methods of construction. These changes are due to two main reasons: First, we have a greatly increased amount of information on the requisites of good paving because we have observed the behavior under traffic of pavement already laid, these observations being supplemented by extensive field and laboratory tests in connection therewith, and second, these changes have been brought about to a large extent by the rapid change in the character and volume of traffic that these pavements are called upon to bear. The requirements of the traffic of today were not even anticipated ten years ago, nor can one predict today what the traffic of tomorrow will require.

Oldest Concrete County Pavement in Iowa

If one were to drive from Mason City west over primary road No. 19, also known as the old North Iowa Pike, to the west line of the adjoining Hancock County, a distance of 40 miles, one would drive over what is the oldest piece of concrete county highway paving in North Iowa and probably the oldest in all Iowa; and one would also drive over a stretch completed in the early part of last October representing the latest type both in design and construction.

The oldest pavement in the stretch just spoken of is on the second mile out of Mason City. This mile was laid in 1913

by county day labor crews at a cost of $10,500, or very nearly $1 a sq. yard. This was paid for from county funds and subscriptions. The pavement is 16 ft. wide and will average 6 ins. thick, with no reinforcing of any kind. The crown on this piece is 1¼ in. The pavement was laid on a loose, fluffy black soil which became very mucky when wet. No tests were run on cement or the sand and gravel. Unwashed material was used. The sand came from a pit on Willow Creek and contained a heavy percentage of red clay. Since then culverts have been built near this pit and material was hauled from Mason City, because the local deposit is unfit for such use. The coarse aggregate consisted of soft limestone, strippings from the local cement plant, and of unwashed gravel abounding in shale and lumps of clay. The material was dumped on the subgrade and shoveled into wheelbarrows and hauled to the mixer. Two inch wooden forms were used and the riding qualities of the surface are about as poor as the concrete itself.

This pavement has been in continuous service since laid. There are numerous transverse and longtitudinal cracks, which are, of course, kept filled with tar. In the last two summers several holes developed due to a raveling of the concrete itself, two on the west end of the mile near the center of the pavement. These are filled with tar and gravel and cause no more trouble. One hole raveled out near the edge and a little later this broke through breaking out a triangular piece about 18 ins. on a side. Another such piece broke out this last summer right over an old wooden 1x1 ft. box culvert, which had been left in and is now decayed. The action of the tires is causing some wear on this surface, but by taking care of the places that ravel this pavement will serve for a good many more years and after it is unsatisfactory as a pavement it will be worth the original investment as a base for some type of resurfacing.

In 1915 the first mile out of Mason City was paved; this lies just between the city limits and the mile just discussed. This also is 16 ft. wide and is 7 ins. thick at center and 6 ins. at the edge. Improvements in the quality of concrete over the first mile are very noticeable. This job was laid by contract at $1.37½ per sq. yd. It is of two course construction. A base course 4 ins. at the edge and 5 ins. at the center, of good clean sand and limestone in proportion of 1:2:4, was laid and immediately after this was deposited a 2 in. top course was laid using granite chips of ⅝-in. maximum size and a 1 to 2 proportion. The 16 ft. width and the 1¼ in. crown were maintained the same as on the previous mile, neither was it thought necessary at this time to use reinforcing, but there was an increase of 1 in. at the center in thickness. It was also decided that expansion joints should be provided. An asphalt filled joint was placed every 36 ft. This, it was thought, would prevent any additional transverse cracks. This was, however, not the case for today fully 75 per cent of these 36 ft. sections have a full width transverse crack. So that in addition to the cracks provided in the construction, there are now transverse cracks betwen these joints as well.

Beveled Edge Abandoned

Another feature on this mile was the beveling of the edge of the paving. The upper half of the paving was beveled off to approximately 45 degs. It was thought that vehicles getting off the paving onto the soft shoulder could more easily get back on again, and that it would prevent spalling of the top edge. This beveling, however, did not prove satisfactory and was not tried again.

This mile after seven seasons of service is in good condition and is showing no evidence of any failures whatever. There are, however, more transverse and longitudinal cracks than there would have been, had reinforcing been used. There is no surface wear at all noticeable and it shows very plainly what the proper selection of materials will do toward the quality of the concrete.

Beginning at the west end of the old original mile and extending thence west to the east corporation limits of Clear Lake lies Federal Aid Project No. 1. This pavement is four miles in length and was started in October, 1917, and completed the following year.

Attempt to Control Cracks in 1917

At this time the 16 ft. width was still considered satisfactory and so it was again used. The same thickness was used as on the second mile paved, namely, 6 ins. at the edge and 7 ins. at the center. The crown was raised from 1¼ in. on the previous mile to 1½ in. and it was decided to use reinforcing on this work in order to prevent the formation of cracks as far as possible. One and one-half miles of this was laid late in 1917, and on this stretch an attempt was made to control the location of the cracks. It was realized that cracks could not be entirely prevented, but it was decided so to place the steel that

it would favor the forming of cracks at certain points. The idea of constructing expansion joints was again abandoned as unsatisfactory because they did not seem to prevent the forming of additional cracks. Two ½ in. reinforcing bars were used for longtitudinal reinforcing, one at either edge and ½ in. bars were placed crossways or transversely every 12 ft. It was attempted to secure the formation of a crack every 62 ft. To do this the longitudinal reinforcing did not continue through these points but left a gap of several inches. A transverse bar was laid on either side of this point and about a foot from it. To insure the cracking in a straight line, two 8 ft. bars were placed longitudinally at the center of the paving, extending away in either direction from this point but leaving a small gap where they failed to meet, just as on the continuous bars, so that every 62 ft. there was a line clear across the pavement that had no reinforcing at all.

Winter came on when 1½ miles of this was laid and work was suspended until the following spring. Eighty-four transverse cracks appeared on this 1½ miles and only 13 came at the points at which a gap was left in the reinforcing. Some cracks developed within 12 ft. of these points. It appeared, therefore, that this method of controlling the cracks would not be satisfactory and as a result of this showing the spacing of the reinforcing as just described was abandoned. The reinforcing was run continuously on the balance of the work with the transverse rods every 10 ft. instead of 12. That is, it was continuous for the day's run. The end of one day's run was joined to the next day's run with dowel pins, same as today.

The end of one day's run snowed in the next day and some of this was frosted a little, but until now no evil effects have been noticed.

There are three separate and distinct kinds of aggregate used on this stretch of paving. The east two miles were built of a green trap rock from Dresser Junction, Wis. Then the labor shortage became so acute that the quarry was forced to close down. The contractor then secured a quartzite from Jasper, Minn., and was able to place another 1½ miles when this quarry was forced to shut down for the same reason. On the balance of the work a local gravel was used from Mason City. No difference in the quality of the concrete seems to be noticeable at this time. The cracks on the section on which the gravel was used are a little farther apart, but the subsoil under this piece is also of a gravelly nature and no doubt this has some influence on the cracking.

This piece of paving is in first class shape today. This road carries an enormous traffic during the year. During the summer resort season there is a steady stream of cars in either direction and now there has developed considerable amount of truck traffic and some passenger bus service. With the growth in the volume of traffic it was now found that the 16 ft. width paving was too narrow. It is true that two cars can pass each other on the 16 ft. width but they have to drive straight and carefully to do so and one does not have the feeling of confidence that is had on the wider pavement. In driving on this 16 ft. pavement one can readily tell if the driver in the car ahead is used to driving on paving. He appears to be worried on the one hand with the fear of getting too far to the left and running into a coming car and on the other hand, he is afraid of getting too close to the edge and running off on the shoulder, so that he shifts his car back and forth.

Greater Width Adopted

By the time the next pavement was laid in 1920 it was pretty generally agreed that 16 ft. was not wide enough and since then 18 ft. has been the standard width except in a few cases where exceptional conditions prevailed and a pavement wider than 18 ft. was thought necessary. (I should not forget to state that Cerro Gordo County paved about two miles of County Road System in 1919 and this was paved 18 ft. wide, 7 ins. thick at the edge and 8 ins. at the center). In 1920 the stretch between Clear Lake and the west line of Cerro Gordo County was paved. As just stated the 18 ft. width was now adopted. The thickness was also increased 1 in., this pavement being 8 ins. thick in the center and 7 ins. at the edges. The crown was raised to 2 ins, 1 in. of which was in the subgrade. An additional longitudinal reinforcing bar was also added and the transverse reinforcing was placed 12 ft. apart. Mason City gravel, sand and cement were used in this piece. The contractor hauled a wet batch. The year 1920 marked the advent of the central mixing plant for general use. Some contractors used the central mixing plants and hauled the wet ready mixed batch, others used a central proportioning plant and hauled a dry batch, consisting of the proper amount of gravel, sand, and cement for one batch and this batch was run through the mixer on the subgrade and deposited in the

forms. The use of the mechanical finishing machine also became quite general in this year as did the use of the subgrader.

In 1920 we had our first experience laying pavement on grades. We soon found that the riding qualities of the pavement on the grades were poor because of short, choppy waves. The concrete after being placed and finished off seemed to flow into ridges and depressions, which gave it a poor riding surface. This flow of the concrete seems to continue until the initial set has taken place. These inequalities of surface can be eliminated, however, by using a 10 ft. straight edge carefully to locate the high spots and then by means of a long handled float work them down. This must be done until initial set has occurred. We have found that the importance of using a straight edge on the surface of the newly finished pavement cannot be too much emphasized, even on level stretches. No matter how true the forms may be, or how carefully the form setter does his work, these depressions and high spots will occasionally occur and can only be detected by the use of the straight edge. We have found that a light straight edge fastened onto a 10 ft. handle makes a handy implement.

In 1920 considerable pavement work was gotten under way, under the provisions of the then recently passed primary road law and the proper inspection and testing of materials assumed the proportions of a large task in itself. It was not only necessary thoroughly to test all materials entering into the pavement, but it was required to do this without interfering in any way with the production and delivery of material. To do this the State Highway Commission established a laboratory at Mason City, from which City all sand, gravel, cement and tile were supplied for northern Iowa. This laboratory sampled each car as it was loaded and by the time the car reached the contractor the report was ready. Every carload of material entering into the pavement received the tester's O.K. before being used.

Change of Thickness in 1921

In 1921 the stretch from the Cerro Gordo County line to Garner was paved. By this time it was successfully argued that there was no good reason why pavement should be thicker at the center than at the edges so that it was decided to make the slab uniformly 8 ins. thick. It was also thought that not enough transverse steel had been used in the past, so this was doubled. The spacing on the transverse steel is now 6 ft. Up to now some of the contractors had used the old fashioned way of dumping on the subgrade and then shoveling into wheelbarrows and hauling to the mixer. Beginning in 1921, however, the specifications prohibited this method entirely, and they also forbade the use of horses on the stock piles at the central plant. The dumping on the subgrade has two drawbacks. It prevents the preparing of the subgrade in the proper manner, and a sufficient distance ahead to insure rapid and continuous operation, and even with the best of care, lumps of dirt and mud would get into the concrete which would impair the strength of the slab and if near the surface form pot holes. Horses were barred from the stock piles for the same reason, to prevent the introduction of dirt and foreign matter into the concrete.

Summary of Changes Since 1913

Not much change was made in the design and the construction from 1921 to 1922.

We have then since 1913 the following changes in design:

1. Width increased from 16 ft. to 18 ft. and more.
2. Thickness increased from 6 ins. center to 6 ins. edge to uniform thickness of 8 ins.
3. From no reinforcing at all, we have now in our present design 600 ft. of steel per station.
4. Curves have been gradually lengthened and flattened until now 200 ft. radii are standard for right angle turns with a carefully designed superelevation and transition curves.
5. Shoulders have been widened from 3 ft. to 5 ft. and grade lines are gradually improved.

In construction the outstanding feature is the elimination of the shovel and wheelbarrow method and the development of the central plant.

The central plant, together with the finishing machine and the subgrader, has resulted in the substitution of mechanical labor in the place of hand labor to a marked degree.

This improvement of mechanical devices has resulted in a greatly increased output per contractor per season, one contractor laying 11 miles of 18 ft. pavement in one season with one mixer.

The pavement of today is unquestionably greatly superior to the pavement laid nine years ago. Who knows what the changes may be in the coming nine years, for we are only at the beginning of a large work and are learning all the time.

The foregoing paper by Mr. Zack was presented at the recent annual meeting of the Iowa Engineering Society.

FEDERAL GOVERNMENT TO DECIDE FATE OF LINCOLN HIGHWAY

The fate of the Lincoln Highway as a great transcontinental route, linking New York with San Francisco, is right now trembling in the balance. The vital question of whether or not the road shall be built west of Salt Lake City, Utah, has at last reached the ultimate authority —the Secretary of Agriculture at Washington, who is empowered by Congress to correlate interstate highways.

The Lincoln Highway Association, with headquarters in Detroit, which laid out the route in 1913, before the existence of a federal authority and before there were State Highway Departments in most of the western states, has spent $950,000 in ten years in the promotion and development of the great transcontinental memorial highway. The road has become the most important and most heavily traveled interstate thoroughfare of its length in the Union and has reached a high degree of improvement from New York City to Salt Lake City, a distance of 2,450 miles. The improvement of the road and its strategic location have brought to it such a tremendous traffic that it is becoming a highly important business factor in every community through which it leads.

Vast Traffic Follows Lincoln Way West

The estimates of 1923 traffic, made by the areas it will traverse, show that some 60,000 cars carrying some 240,000 people will traverse the West on the Lincoln Way, spending in the aggregate, between Cheyenne, Wyoming, and the Pacific Coast, over $25,000,000. The construction and proper maintenance of the Lincoln Highway in the West has thus become a question of vital importance, not only to travelers from every section of the Union, but particularly to the vast areas anticipating the business of these travelers.

Every state through which the Lincoln Highway passes between the Atlantic and the Pacific has made the famous route a portion of its federal aid system, with the exception of Utah. Utah has refused to incorporate that section of the Lincoln Highway between Salt Lake City and the western Utah line is its federal aid system, such action precluding the proper completion and maintenance of that highly important section of the road across the Great Salt Lake Desert connecting with the Nevada line and, in effect making Salt Lake City the western terminus of the Lincoln Way. Utah wishes to abandon completely that link in the Lincoln Highway. As this is the road which connects with the main central route across Nevada, that great state is naturally desirous of its prompt improvement. Nevada citizens, chambers of commerces, civic and commercial organizations of all kinds, and her officials, including county commissioners, the State Highway Commission, the Governor and the Legislature, have urged upon Utah without success the inclusion of the Lincoln Highway in her federal aid system and the completion of the road which was indorsed in 1913 by the governor, William Spry, and in 1918 by then governor, Simon Bamberger.

Utah's Plan to End Lincoln Way at Salt Lake

In 1918 Utah accepted $125,000, contributed by the Lincoln Highway Association, and spent it, together with some $80,000 more of state funds, in starting the construction of a satisfactory highway across the Great Salt Lake Desert. That improvement has never been completed. The state did not have sufficient funds to complete it during Governor Bamberger's administration. But the Federal Highway Act, passed in November, 1921, made additional large sums available to Utah from the United States treasury and would have permitted the completion of the last important gap in the road 3,305 miles long. However, the present administration of the state of Utah refuses to build the road. Abandonment of the work already accomplished on the Lincoln Way will mean that it will rapidly become totally impassable, thus blocking all traffic headed for the Pacific Coast on the Lincoln Highway.

The protests of the Lincoln Highway Association, of the Legislature, the State Highway Commission and the Governor of Nevada, and of the people of that state have had no effect upon the "powers that be" in Salt Lake City, with the result that the matter has finally come to the "court of last resort," Secretary Henry C. Wallace, of the Department of Agriculture, of the United States government.

If Secretary Wallace follows the wishes

of the Legislature of Nevada, as formally expressed, the Lincoln Highway will be saved and it can still become America's greatest and most important transcontinental backbone of transportation, and the eternal memorial to Abraham Lincoln conceived by its founders. If the secretary follows the wishes of the present Utah political regime, the Lincoln Highway will cease to be a transcontinental road and become but a road from New York City to Salt Lake City.

Tourists' Convenience or Utah's Profit?

To a large extent the question involved is whether or not traffic shall take the natural, easiest and most direct, safest and most pleasant trend of travel to either San Francisco or Los Angeles, or whether it shall be diverted, rerouted and forced through areas seeking larger proportions of that $25,000,000 a year tourist business, which now forms the stake in the gigantic game of road strategy Utah is playing.

The state of Nevada appreciates that Utah's objection to providing a proper western outlet is based on the obvious desire to make Salt Lake City the division point for that vast volume of through traffic headed for southern California which, if the Lincoln Highway is abandoned and allowed to become impassable in western Utah, must necessarily turn south at Salt Lake City, traversing the entire length of the state of Utah and then following through 400 miles of the Mohave Desert, touching but a corner of Nevada on its journey to Los Angeles.

The remark attributed to Mark Twain, in commenting on his experiences in India, applies with almost equal appropriateness to this Mohave Desert area through which Utah would route all travel for southern California. He said, speaking of the "cool season" in India, that that was a phrase which had come into use in India through the necessity of having some way to distinguish weather which would melt a brass door knob and that which would only make it mushy. July, August and September, the months of greatest tourist traffic through the west, are not the "cool season in the Mohave Desert.

Nevada knows that more than half the travel reaching Salt Lake City and destined for California is headed for southern California and that the best route to southern California is through Ely, Tonapah, and Goldfield, a route which saves the tourists 56 miles between Salt Lake City and Los Angeles and eliminates the intensely disagreeable and almost dangerous Mohave Desert trip. Utah well knows the value to the state of those extra days in Utah forced upon Los Angeles travel if no outlet west of Ely, Nevada, is provided.

Happily, the decision is finally in the hands of a man with no interest in these local strategems for securing the tourist dollars—in the hands of a man who can view the situation from the standpoint of the through traffic and decide it in the interests of all future travel across America. Through travel, or "foreign cars" is 90% of all the travel on the east and west roads of Utah and Nevada. The United States government pays 74% of the cost of the roads.

Until Secretary Wallace pronounces his decision in the matter the continuity of the Lincoln Way as a direct connection from Manhattan to the Golden Gate is threatened. The eight states between Wyoming and the Hudson River, which have done so much in ten years to make the Lincoln Way a connecting actuality, have a vital interest in the momentous decision soon to be reached by Secretary Wallace; momentous because it will affect the travel of hundreds of thousands of tourists in the future. Nevada and California have a tremendous interest at stake.

PUBLIC HEALTH AND WATER CONSUMPTION

By Abel Wolman, Chief Engineer, Maryland State Department of Health, 16 West Saratoga St., Baltimore, Md.

In the discussions on the meter question heretofore presented before the Engineers Club of Baltimore, that elusive individual, "the average citizen," has been subjected to careful analysis with respect to his taxes, his water-rent, his front-foot assessment, his general economy and his public spirit. The Committee of the Engineers Club has felt it only fair, therefore, to present to you some statement, however brief, of the effect of curtailed water consumption upon the "average citizen" himself. After all is said and done, we should know whether a reduction in water consumption will be physically harmful to our residents. If it is harmful, no amount of engineering argument or financial expediency will warrant curtailment of water use. The previous speakers have assumed that a reduction in water use in Baltimore is possible without detriment to the individual or

public health. The pertinent question before us is, therefore, whether this assumption is warranted.

It is my plan to present certain data without drawing therefrom any conclusions. This apparently unsatisfactory plan of presentation is adopted in the certainty that all will have no difficulty in reaching common agreement as to whether or not consumption of water may be reduced in Baltimore without damage to the individual's health and cleanliness. Whether such reduction in consumption, if desirable or possible, should be brought about by metering, or by awakening of public conscience or by some unknown method is hardly within the province of the present discussion. My concern is with the possibility of reduction of water use and not with the technique of its accomplishment. The two problems are entirely distinct, for the first is concerned with the question: Does the "average citizen" use more water than he requires?" while the second asks: "How can we stop him, if he does?"

Water Needs

It sounds comparatively easy to ask how much water an individual needs, but it is not always so easy to answer. The figures usually quoted in the statistics marshaled in any argument for or against water meters mean little except as average indices of current usage. They represent "use," not "need," or "desirability." Current value for per capita consumption may sometimes be lower than that inherent in necessity or desirability, and frequently higher. It is only rarely that the figures are synonymous.

Why should such discrepancies between "use" and "demand" occur? Obviously, use of water is a function of the absence or existence of artificial restrictions, while demand is a function of the natural requirements of biologic life or of sanitation. The amount of water a person uses in a community is rarely as low as his requirements for physiological functioning and for proper sanitation. His consumption is more often determined by purely artificial measures, such as whether the water supply is metered or not, whether it is gravity supplied or pumped, by local prejudices, by previous history, by abundance or lack of supply, than by real demand. In other words, man's usage of water in a modern community is guided by whether he pays for it or not, by his public conscience, by custom and other external contingencies. These distinctions are emphasized here because in them lies the origin of the confusion which arises when we speak of man's water requirements and his health.

Rational Requirements

Man has certain minimum requirements for water in order to continue to function. The human mechanism demands water for its proper functioning, just as an automobile engine demands gasoline. The ton-miles per gallon of gas differ with different engines, at different temperatures, at different speeds, etc. In the same way, the human engine has varying requirements for water, one of the constitutents of its driving power. But the maximum requirement of biologic man for water is ridiculously low in comparison with the figures for water consumption with which we are familiar.

The "subsistence demand" of man, if we may so term his metabolic water requirement, is one of the rational requirements of man. It is rarely over a gallon and a half a day and is frequently less. The British troops of General Allenby in their forced marches against the Turks used as low as one pint of water per man per day. It is hardly wise to assume such a minimum rate, even though experience may indicate no harmful results. We are safe, however, in accepting the figure of 1½ gals. per man per day as a rational value for "subsistence demand."

The modern individual has another demand which is quite as worthy of fulfilment as his "subsistence demand," namely, a "sanitary demand." As modern sanitation developed, man's use for water increased, as it should. Such legitimate increases, however, were frequently perniciously employed to excuse illegitimate and wasteful increases in consumption which occurred simultaneously therewith. The "sanitary demand" of the individual is that covering the usage for bathing facilities, washing of clothes, toilet equipment and minor necessary household uses. Measurements have been made from time to time in large communities of the total water used for above purposes in typical areas. It is commonly found that this figure for "sanitary demand" varies between 10 and 20 gals. per person per day.

The sum of the "subsistence" and "sanitary" demands range from 15 to 25 gals., therefore, per day for the domestic consumer. If we pursue the usual custom of engineers, we may extend this figure to include a factor of safety, giving a "maximum rational water requirement" of 30

gals. per person per day in domestic service. We take no account in this evaluation, of course, of commercial or public usage of water, for these should not be confused with the individual's personal use. They represent an added necessity, but they should be separately tabulated as remote in their effect upon the public health.

Is this "maximum rational requirement" of 30 gals. per capita per day, for domestic purposes, a hypothetical desideratum or a practical accomplishment? In other words, should calculation supersede experience in determining the allotment of water to consumers? Fortunately abundant evidence is at hand to confirm the conclusion that many communities have used quantities of water for many years which agree, within reasonable limits, with the rational individual demand above indicated. It would be useless to quote such figures at length here, but I shall take the liberty of referring to a few examples to satisfy all that the "rational demand" set up by the present writer is not irrational.

It has been common knowledge for decades that American cities are notoriously wasteful of water in comparison with foreign communities. It is also as well known among persons familiar with mortality statistics that in many of those foreign areas the death rates from waterborne and other diseases have been lower than in American cities. It is only in recent years, for example, that the typhoid fever death rate in Baltimore has approached within range of the low rate for this disease which London has had for decades. And yet the daily per capita consumption of water in London is less than 50 gals., while the average for the principal towns in Great Britain is only 42 gals.

A survey of American mortality statistics does not indicate any correlation of frequency of incidence of disease with varying amounts of water consumed or with whether a community is metered or not. The correlation of water and disease, in the bulk of cases, lies in the factor of quality and not of quantity of water consumed, for, in most instances, in this country, water consumption is well above the rational requirement and usually above 50 gals., which we may designate the "maximum reasonable use." Beyond 50, however, the irrational use of water for the domestic consumer begins, for in this upper zone lie the demands upon a system made by waste and leakage. The responsibility for waste and leakage rests with both individual and municipality. It is in this region that curtailment may well be made without damage to health.

Maximum Reasonable Domestic Consumption

The establishment of a "maximum reasonable use" of 50 gals. per day for the domestic consumer has additional support in the facts which may be gained from the experience of American cities which have adopted water meters. As their per capita consumption decreased, the typhoid and total death rates fell. It would certainly be rash to assume that the two phenomena had anything to do with each other. Yet, it is probably as accurate to state that reduction in water use decreases the death rate as increase in water use decreases the death rate, for both conclusions are by no means obvious or necessary. Reduction in water use may increase the death rate, if such use were reduced below the rational demand to the region of "subsistence demand," because then interference with the communal and individual equipment for sanitation results. To say, however, that reduction of the individual's use from 100 to 50 gals. per day implies higher mortality is equivalent to saying that the substitution of a good washer for a poor one on the tap at the kitchen sink will cause a greater frequency of disease. In either case, we are merely curtailing an irrational usage of water, without interfering with a rational demand.

I am not prepared to state, of course, that the reduction of domestic use in Baltimore will be brought about by meters, for we must first know whether the irrational use originates in the leakage and waste in the public or in the private distribution system. Much depends upon the source of this irrational demand, if it is appreciable, as to what procedure is desirable or economical for its elimination.

The Cleanliness Argument

My purpose has been to point out that the requirements of the human mechanism for water for continuance of life and for proper environmental sanitation are relatively low. In only few instances, do such requirements control the actual per capita consumption in a community. It would be a better statement of our case if we were to revise the usual argument for unlicensed water use, namely, that "cleanliness" may be reduced by curtailment, to the more accurate phrase, that

TABLE I.—DATA ON WATER CONSUMPTION—METROPOLITAN BOARD OF WATER SUPPLY AND SEWERAGE, NEW SOUTH WALES, AUSTRALIA.

Year	Population Supplied	Average per capita Consumption Gallons (U.S.) (for all purposes)
1911	731,180	49.8
1912	776,065	50.4
1913	830,560	52.8
1914	878,790	49.0
1915	917,990	51.5
1916	968,215	50.0
1917	993,000	49.9
1918	1,021,540	53.5
1919	1,060,230	54.4
1920	1,109,430	52.5
1921	1,146,370	53.3

TABLE II.—ENTERIC FEVER IN ADMINISTRATIVE COUNTY OF LONDON, ENGLAND.

Year	Deaths per 100,000
1911	3.0
1912	3.0
1913	3.0
1914	3.0
1915	War Period Rates Unreliable
1916	War Period Rates Unreliable
1917	War Period Rates Unreliable
1918	War Period Rates Unreliable
1919	War Period Rates Unreliable
1920	War Period Rates Unreliable
1921	1.0

Population supplied approximately, 4,500,000.
Average water consumed per capita per day in 1921-22, approximately 50 gals. (U. S.) for all purposes.

TABLE III.—PER CAPITA CONSUMPTION ALLOWANCES FOR VARIOUS CLASSES OF COMMUNITIES SERVED BY APULIAN AQUEDUCT SYSTEM, SOUTHERN ITALY.

U. S. Gals. per Cap. per Day	Communities (Population)
32.8	Bari, Lecce, Foggia, Barletta, Toranto
	Gravity Supply
22.2	More than 20,000
19.2	10,000—20,000
16.9	5,000—10,000
15.6	5,000 or less
	Pumped Supply
15.6	10,000 or more
14.4	5,000—10,000
12.7	5,000 or less

Population to be served, 3,000,000.

TABLE IV.—DATA FOR BALTIMORE

	Typhoid Fever Deaths per 100,000	Water Consumption Per Capita Per Day
1911	27.1	120
1912	23.6	
1913	23.1	
1914	22.0	
1915	20.3	
1916	17.1	
1917	15.0	
1918	11.6	180
1919	8.2	166
1920	4.7	
1921	5.6	142+—

"water consumption" represents not only a demand for cleanliness but a wasteful usage. Nor is this irrational wasteful use always restricted to the consumer, for in some communities the water, fire and street cleaning departments also invoke the "cleanliness" argument to explain away their human frailties. It should be emphasized that a leaky main or a fire-plug left open while the moody street cleaner discusses at length the dangers of civilization with the innocent bystander, bring us no closer to the path of cleanliness, yet this quantity of wasted water appears later in the innocent role of defender of health and welfare. We should be wary of the false god of cleanliness, "waste," while we protect the real one, "rational usage."

I have not attempted to burden this paper with tabulations to support my brief, but there are appended hereto several typical exhibits which may serve to illustrate the argument analyzed above.

In closing, I may summarize by saying that I consider the "subsistence demand" to amount to 1½ gals. per person per day; the additional "sanitary demand," from 10 to 20 gals. per day; the "rational water requirement," 15 to 25 gals., with a maximum of 30 gals.; the "maximum reasonable use," 50 gals. These values should be compared with an average present use, which includes irrational waste and uncontrolled leakage, commercial and municipal use, of 142 gals. in Baltimore.

The foregoing paper by Mr. Wolman was presented before the Engineers' Club of Baltimore on March 21, 1923.

IRON ORE USED IN LOUISIANA ROADS

Iron ore, found in northwestern Louisiana, has proven of great value in road building in that state and, in some localities where it has been used, has effected a saving of $2,000 to $3,000 a mile in the cost of construction. Highway engineers in Louisiana have been using the ore as a binder instead of sand clay and have found it far superior to that material in many instances. During 1922 the Louisiana State Highway Department completed 350 miles of new roads. Most of this mileage consists of gravel. The remainder consists of roads built of shells, sheet asphalt or bitulithic.

Iron ore was first used in DeSoto Parish, La., in 1917. Then a large deposit was found northwest of Arcadia. Ore from this deposit is being used as a base course on the new Homer-Minden Highway, the Arcadia-Natchitoches Highway, the Ruston-Arkansas Highway and the Pershing Highway. The state pays about 10 cents a yard in royalties for this material against $1 a yard on sand clay gravel.

Construction News and Equipment

USE OF CONVEYORS TO SAVE LABOR AND PREVENT ACCIDENTS IN MATERIAL HANDLING

By H. L. McKinnon, Secretary, The C. O. Bartlett & Snow Co., French St. and Columbus Road, Cleveland, Ohio.

First, I would like to classify the various types of conveyors generally in the following manner: 1. Screw conveyors. 2. Bucket elevators. 3. Belt conveyors. 4. Apron conveyors. 5. Flight conveyors. 6. Skip hoists. 7. Portable cranes. 8. Bridge cranes or tramways. 9. Monorail system. 10. Air and steam jet systems.

Just a word of explanation as to these various types of conveyors and the ordinary safety precautions which are taken in the manufacture of each.

Screw Conveyor

This type of equipment is usually built in a completely enclosed trough, having a removable cover and suitable gates in the openings for receiving and discharging the material. The operation of the equipment is merely that of the helix or screw moving the material forward in the trough by means of the spiral flight which is supported usually on a hollow shaft and is driven through this shaft by a gear or other drive at end of the trough.

It is easy to see that an equipment of this kind when totally enclosed, practically eliminates any chances for accident in its operation if the gears and drive are enclosed, also, as may be readily done. Normally there is no possible opportunity for accident. Yet, it is one of the most painful recollections of the writer that one of the worst accidents which he ever witnessed was in connection with just this kind of equipment. The conveyor in question was in a warehouse containing finished Portland cement, and a series of gates from the various bins were provided in the chutes leading to the conveyor in question. The operator found one of these gates a little hard to open and rather than take the necessary trouble and time to get a bar and force the gate open, he attempted to kick the gate and in doing so, missed it, putting his foot in the conveyor, which promptly resulted in amputation a little above the ankle. Such accidents are by no means rare and are the direct result of carelessness, although the possibility for accident is always present when an opening is provided with removable cover over any moving piece of machinery. These screw conveyors are rarely used to handle anything but a fine material or at least a granular product with lumps in no case larger than one-quarter the diameter of the helix.

Bucket Elevators

Great variety in the design of bucket elevators is noted and there are certain limits in the practical constructions of this class of equipment. Bucket elevators may be either vertical or inclined at an angle to the horizontal. They can be used for a wide range in material but the size of the product to be handled will determine in every instance the minimum size of elevator that may be used for any particular purpose. It is usual completely to enclose bucket elevators where they are vertical and where they handle a product that is likely to create dust. It is not, however, essential from the standpoint of safety that they be placed in a dust-proof casing. It is, however, desirable to protect elevators at any point where there is an operating floor or where men can come in contact with the moving line of buckets and chains or belts as the case may be. It is also usual to protect the gears on the drive so as to prevent accidents, due to the attendance rendered necessary for the oiling and maintenance of parts. There are a great many bucket elevators, however, built on incline with the horizontal where the construction is of skeleton nature and the moving parts are exposed. Where the rate of travel is slow, this need not necessarily be dangerous provided the outer ends or the rolls and chains are protected, so that the clothing of an attendant cannot be drawn under these parts so as to cause accident.

Such elevators are frequently provided with guard rails on the outside of the bucket line so that in the event of a breakage of chain or belt, the buckets will be held in position without being allowed

to roll down to the foot end of the conveyor and in so doing, probably injure workmen in so dropping.

Many devices are resorted to by conveying engineers to render such equipment entirely safe under the most adverse operating conditions.

Belt Conveyors

The uses to which belt conveyors are now applied are so various and so comprehensive in regard to the materials handled as to present a great variety of problems in making the conveyor safe in continuous operation. In the first place, belt conveyors are usually operated at fairly high speeds, which makes the chance for accident greater than is the case with slower moving equipment. They are operated at speeds in some instances as high as 2,000 to 3,000 ft. per minute, in which cases material is thrown from the end of the conveyor at a corresponding velocity and momentum.

If a workman should get in the path of material moving at such a rate he has scarcely an opportunity of getting away uninjured. The great majority of belt conveyors however, are operated at speeds varying between 200 and 400 ft. per minute, which latter speed is not much in excess of normal walking speed for a healthy full-grown man, and it is usually possible for any one who is alert to avoid possibility of accident with this class of equipment if it is properly constructed and supported. It is, of course, essential that the drives, especially the gears, be protected in the same manner as has been specified for previous items. It is now usual to make belt idlers for conveyors so that there is no possible projection which could catch loose clothing or anything else in the movement of these idlers. One of the most important things to be considered from the standpoint of safety is that the practical means of lubrication be provided with such regard to safety precautions as would make it practically impossible for the person operating the lubricating system to become in any way injured with moving products.

Apron Conveyors

The term above mentioned, namely "apron conveyors," is usually employed to designate a type of conveyor which is jointed and yet in all other essential particulars is similar to the belt conveyor described in the previous item. With apron conveyors, however, it is quite usual, and in fact general, to supply sides on the conveyors which make them act as a trough and the same problems are presented as in the open type elevator in the matter of projecting chains and idler wheels which are carrying the load. Guard rails should be provided in this class of equipment so as to eliminate any possible chance, if the apron conveyor is on an incline, of the material piling up at the foot end due to the breaking of the chain or other parts. The same general conditions in regard to drive protection are necessary on this as in all other instances.

Flight Conveyors

We here come to the discussion of one type of equipment which, while it is usually slow-moving, does have possibilities for accident, due to the fact that it is usually supported in an open frame work of structural steel or wood, which will permit individuals to fall in it if it is not otherwise protected, or the further possibility of allowing bars or other equipment to fall into the equipment. If they are too long to fall into the conveyor directly, they are liable to catch in the construction and injure anyone in passing. These flight conveyors are used for a great variety of materials and are practically the only type that can be used successfully on certain materials, such as household waste, commonly called garbage. Products of a similar nature, if handled in conveyors, usually must be handled in an equipment of this type, especially if there is more than one point of delivery from the conveyor. Belts or aprons can be used for the conveying of materials of this character if delivery is only at one point. It is quite practical however, to protect by means of hand rails and toe boards, this class of conveyor in such a way as to render it perfectly safe for the operator.

Skip Hoist

This term is used to cover the form of elevating equipment which consists of one or two buckets either balanced or not, as the case may be, which are used as a hoisting tower and hoisting engine so as to elevate any material which can be readily placed in the buckets and hoisted and dumped in any desired position. This class of equipment consists essentially of a loading hopper with suitable gate and gate mechanism, the bucket guides or hoisting frame and the hoisting engine itself together with the dump chute or hopper for receiving material.

It is generally easy to protect the hoisting tower in such a way that even if a rope breaks, the bucket will only drop directly in its guides and fall to the bot-

tom without endangering the life of any individual.

Many things have been done in the construction of skip hoist equipment to render it as safe as possible and as in the case of all dryers, the gears are to be completely enclosed.

In the more modern equipment, there is usually provided limit switches where the equipment is operated by electric motors so as to control the travel in either direction. In addition, the slack cable device is frequently employed in the event that the rope becomes slack, due to the bucket sticking in the guides. This immediately cuts off the power.

Still further safety is obtained in the event that the bucket is hoisted to too high a position; that is, above its normal dumping point. Various devices have been provided so as to hold the bucket locked in position when it is carried above its proper limits. These are intended for safety, and also for reduction in risk to the equipment, due to the faults which might develop in the operation.

Locomotive Cranes

The type of equipment here mentioned is familiar to all and the use in industry is so general as to need no explanation.

Aside from the proper covering of driving mechanism gears, it is necessary to be sure that the various parts of the equipment are sufficiently strong for the service in which the machine is operated. In the writer's experience, the greatest danger encountered in the operation of this type of equipment is in the handling of heavy equipment where it has to be placed together in other parts for proper assembling. It is then that the man who is directing the operation comes to be in danger, first, in attempting to guide two parts together and possibly due to the failure of ropes or brakes on the equipment itself. There are, however, a large variety of uses for this kind of equipment where it can be handled with perfect safety and to the great advantage of the business using the equipment.

Bridge Cranes or Tramways

We do not propose to discuss at any great length this type of equipment. All that has been said in the previous item in regard to the handling of materials with a locomotive crane applies with equal force to the handling of parts on the overhead traveling or bridge crane, or with a bridge tramway which is usually used in connection with clam-shell buckets or drag lines. The same general principles of protection against accident apply to this equipment as in the previous item.

Monorail System

We come here to a type of equipment which is a modification of the cranes in the two previous items, but on account of its flexibility in switching from one track to another, it has been used in a great variety of places where bridge cranes could not be used without great expense. However, we have observed in connection with this kind of equipment that the use of switches getting from one track to another involves great risk of accident.

To the writer's personal knowledge in one foundry where switches are not permitted, no serious accidents have been caused in the handling of molten iron in hot ladles in monorail system, while in another foundry owned by the same interests and operating on identically the same class of work, seven or eight persons have lost their lives in a few years, due to the spilling of hot iron when the monorail equipment runs into an open switch or one improperly set, which suddenly stops the trolley.

It is the writer's opinion that this type of equipment is, from the very nature of its construction, difficult to protect from this standpoint. Suitable bumpers and automatic stops probably could be designed or a system of signals employed which might relieve this mechanism of defect mentioned.

Air and Steam Systems

As a means for transferring material from one point to another, steam and air have been used for many years. There are certain objections to this type of conveyor, chief of which is its inefficiency from the standpoint of the power required to operate. The efficiency of such type of equipment in only rare instances is as high as 15%, and is more often under 12%. Such an equipment is practically accident-proof, however, except due to defective containers for air or steam and the possibility with the use of steam, that the operator might come near the outlet and become scalded due to an excess of steam passing through the equipment.

With these descriptions of the various types of conveying equipment, and considering the diversity of materials which must be handled, nothing but the most general statements can be made which would have application to the question before us. We believe, however, that we

are safe in making this assertion, namely, that where materials are handled by mechanical means, which means conveying systems as opposed to operating by hand, the chances for accident are reduced in two important ways:

First—In a reduction of the number of operators.

Second—In the freedom of the mind of the operators required in connection with mechanical equipment so that they may guard against accident.

The writer has made a special study of labor-saving by the use of mechanical equipment in the foundry industry and has found some very remarkable instances in reduction of men required to produce a given amount of work. We have in mind one instance where the output of a plant was increased 60%, the floor space occupied with work reduced 50%, and the number of employees cut in half. Working conditions were so much improved in this plant that when it was found necessary to shut the plant down in the fall of 1922 for a period of six weeks, all of the help were paid off excepting the foundry foreman. These men obtained work in other plants, but when the plant under consideration was ready to again begin operation, a post card sent out three days in advance, brought back all of the employees but four on the first morning of operation, and on the third day of operation, all the old employees were in their places. We have not the figures from this concern in regard to the number of accidents before and after the installation of the equipment, but feel sure that they will show in the right direction.

We have, from another customer, the statement that the number of accidents per ton of castings produced, had been greatly reduced by the addition of mechanical equipment and they verify this statement by their dispensary record.

Another gentleman in charge of safety work for a branch of the Steel Corporation stated to the writer that there is absolutely no question but that the use of mechanical equipment for the handling of materials has reduced their accident record, and why should this not be so?

In the first place, conveying equipment is made to do the thing in the easiest possible way; that is, with the least expenditure of total effort. Again, by the use of mechanical equipment, feeders may be installed so as to transfer material from bins to conveyors, provide for an even and continuous flow, and eliminate the guess work of hand feeding which, in some operations, when fed too fast or too slow, are liable to produce causes for accident.

The foregoing paper was presented recently in Chicago before the mid-year conference of the Safety Council.

CHAUSSE OIL BURNING ASPHALT TOOL AND SURFACE HEATERS

Shortage of labor for street and highway repair work has caused considerable interest in the return to production of the Chausse oil burning apparatus for repairing asphalt streets with greater efficiency and economy than is experienced through the use of manual labor only.

The wide necessity for increased economical maintenance of asphalt pavements, the advantage of hot patching over cold patches and the saving of both time and money secured by the use of improved machinery has focused attention on apparatus for rapid street repairing.

About five years ago Chausse machines

VIEW OF IMPROVED CHAUSSE ASPHALT TOOL HEATER.

were introduced to street and highway departments and through two years of production made enviable records. With improvements made in these machines, ample production facilities and a record of success behind them the Chausse oil burning tool and surface heaters have been returned to active distribution. The accompanying illustrations show Chausse tool and surface heaters which are used in a great number of cities and by a large number of contractors. The new features of these machines combine meritorious features of the old apparatus with refinements which have been found desirable.

The tool heater as illustrated is now equipped with rubber tires, Timken bear-

ings and steady rests and a new type of burner. The artillery wheels and roller bearings make possible more rapid and noiseless transportation so that they can be hauled at any speed behind motor trucks. The new burners are more efficient and unaffected by the high temperature generated. The new steady rests both front and rear, prevent tipping and these machines can readily be pushed by one man. The surface heaters have been improved by more efficient burners and

VIEW OF IMPROVED CHAUSSE ASPHALT SURFACE HEATER IN OPERATION.

lifting apparatus and refined insulation.

Chausse tool heaters or fire wagons will bring 14 or 15 cold tools up to a proper temperature in 15 minutes and provide space for heating 3 buckets of cement so that two gangs can work on one machine if necessary. The burners will generate maximum temperature in 5 minutes as it is no longer necessary to build up coal or wood fires long in advance of the machine's use. They eliminate smoke, sparks and ashes and are not affected by rain or wind. Sufficient kerosene or distillate is carried for two 8-hour days of continuous burning at maximum temperature. The fact that there is no danger in the use of these machines and no possibility of damage to awnings or objections from householders make them more satisfactory, it is claimed, than coal or wood burning apparatus.

Chausse surface heaters are made in two sizes, one to cover 2 sq. yds. and to work up to street car tracks without interfering with car movements. The other covers 4 sq. yds. and both machines are mounted on springs to prevent damage in transit, and both fold up to facilitate transportation. The cutting edges all around the burner hood give clean straight joints and it has been found possible in actual service to melt down old asphalt to 1-in. depth in 4 to 5 minutes. As much as 600 sq. yds. of asphalt has been heated to a 1-in. depth in an 8-hour day. In the city of Detroit, one Chausse surface heater and 2 men were able to do the work of 4 men chopping out, and at the same time saved 1 in. of asphalt and 1⅛ in. of binder in addition. Hand chopping meant taking out everything right down to the base so that the Chausse machine saves both labor and material and in the completion of approximately 80,000 sq. yds. of asphalt repairing the Chausse heater reduced the cost from $1.22 to 97 cts. per sq. yd.

These machines are now being offered to the trade by the Chausse Oil Burner Company, with offices at 206 Lincoln Building, Detroit, Mich.

USE CENTRIFUGAL PUMP TO ICE LOGGING ROADS

Indicating the widespread and varied uses of the little Evinrude Centrifugal Pump, one is now at work icing logging roads in the Canadian north woods near Hudson Bay. This is the Evinrude's "farthest north" to date.

The pump is slung down a water hole and lifted up to drain, to prevent freezing.

Its owner is one of the Dominion's large lumber companies, and the order was filled by Watson, Jack & Co., Ltd., Montreal, who represent the Evinrude Motor Co., Milwaukee, in Canada.

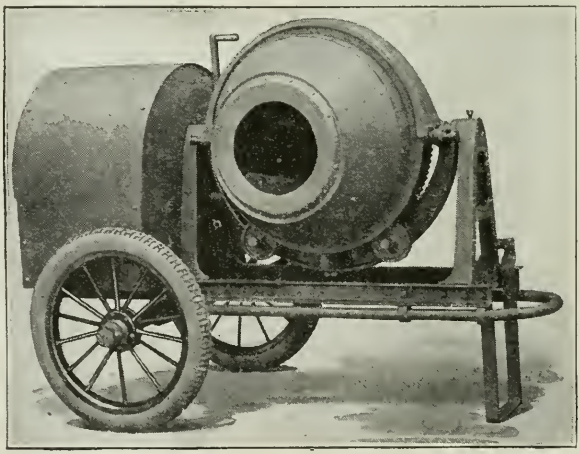
NEW MACHINE IN SMALL MIXER FIELD

Now and again some invention or development is brought out which, because of its importance, causes an unusual amount of comment. Such is the case with the new Smith 375 Tilting Mixer just being placed on the market by the T. L. Smith Co., of Milwaukee.

This little half-bag mixer is built along exactly the same lines as the larger known mixers of larger size. The double cone drum is known for its fast continuous production and speedy discharge (just like emptying water from a bucket). The tilting lever operates easily and locks in the discharge position. The drum returns to the mixing position automatically as soon as the lever is released. No time or effort is wasted.

SMITH 375 HALF-BAG TILTING MIXER, FOUR-WHEEL MODEL SW-1, CHARGING SIDE WITH FEED CHUTE AND LOW CHARGING PLATFORM.

The new mixer has a mixed batch capacity of 3¾ cu. ft., or a full half-bag batch of 1-3-6 mix with materials containing the usual 40% voids. It supplements the Smith line of tilting mixers and meets a real demand for a small size mixer of design and merit.



ANOTHER VIEW OF SMITH ½ BAG TILTING MIXER. PRESSED STEEL WHEELS ARE FITTED WITH CLINCHER RIMS FOR FORD 30x3½-IN. PNEUMATIC TIRES.

Smith tilting mixers, known to contractors for over 20 years. The double-cone drum, the central gear ring and roller track, the independent tilting frame—these are all the same as on the well-

In spite of its small size, it is claimed

that this mixer is the best made machine in the entire Smith line. The inspection is extremely rigid and the parts are made to very close tolerances. The main drive gear and the engine pinion are machine-cut. The bevel drive pinion is made of 40% carbon electric steel. The chilled thrust rollers have enclosed dust and moisture-proof ball bearings. The bolster castings are of electric steel and the operating levers of malleable iron. The power plant consists of a 1½-h.p. Fuller & Johnson engine, equipped with a magneto. It is completely housed.

The feed chute is made of No. 12 gauge steel plate. The charging platform is built of 1½-in. boards bolted to heavy steel angles. The height of this platform is 30½ ins.; width, 32 ins.; length, 42 ins.

Smith 375 Tilting Mixers are built in two models. Model RW-1 is equipped with two pressed steel wheels fitted with clincher rims for Ford 30x3½-in. pneumatic tires. Model SW-1 has four steel wheels, 24 ins. in diameter and 3-in. grooved treads. Axles on both models are made of cold rolled steel, 1¾ ins. in diameter.

The two-wheeled model RW-1, with its light weight (only 1,100 lbs.) and pneumatic-tired wheels, is the last word in portability. With a hauling stub that is so arranged that it can be drawn out for readily attaching the mixer to an automobile, truck or wagon, this little mixer can be towed quickly from one job to another. While the mixer is being moved, the front supporting leg is folded up out of the way.

THE CARR ROAD FORM

The Carr Road Form, recently placed on the market by the Lakewood Engineering Co., Cleveland, Ohio, has a number of distinctive features. The cross section of the form is made by 3/16 in. metal. The locking arrangement consists of two simple wedges and insures accurate and rigid connection of sections.

The sections of form are made in 12-ft. lengths, which is 20% longer than has been customary for road forms and decreases the number of joints to be made and the sections to be handled in a given distance.

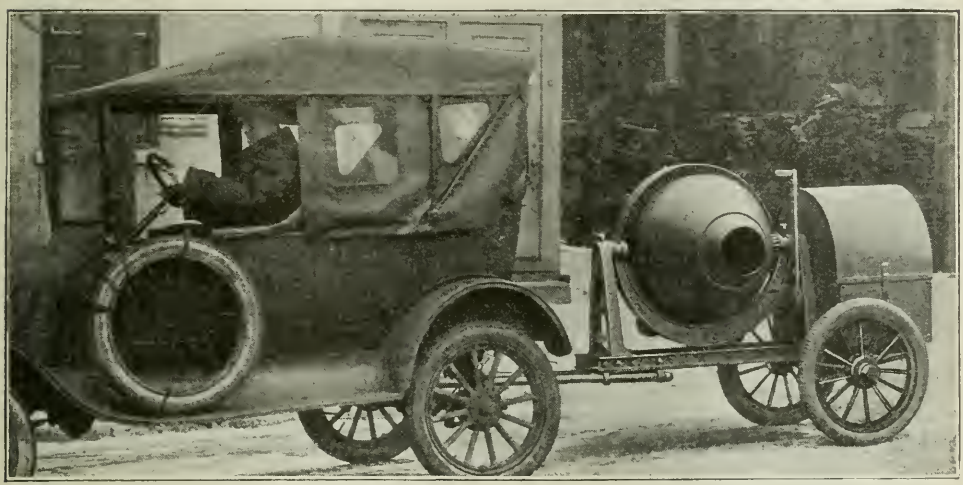
One of the most important features of the form is the Line Point Top Surface, which is secured by the rounded top. No concrete or stones can lodge here to get under the wheels of the finishing machine or subgrader to cause them to ride high.

The form is practically self-cleaning. Edging is made easier because of the uniform top and smooth joints which result from the rigid connection between sections secured by the wedge members.

Flat stakes having a penetration of 18 ins. and which can be driven anywhere along the base of the form are another point of superiority. The shape of the stake gives it maximum resistance against displacement.

The base is 5 ins. wide and furnishes ample bearing to support the forms when carrying mechanical finishing and subgrading machines.

These forms were used on several jobs last season in order to thoroughly try



VIEW SHOWING METHOD OF TOWING SMITH ½-BAG TILTING MIXER BETWEEN JOBS AT HIGH SPEED.

them out before placing them on the market. These jobs proved that the advantages of the form are of real practical value.

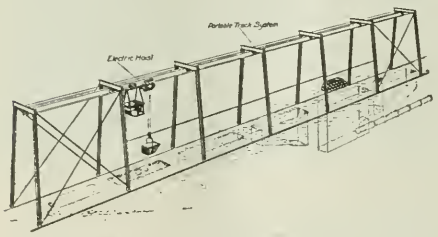
ELECTRIC HOIST MONORAIL SYSTEM FOR LAYING SEWER PIPE

A most effective method of laying sewer pipe has been put into operation by a contractor in Hagerstown, Md., which will appeal to contractors doing similar work or confronting like conditions.

Confronted with narrow streets and the necessity for keeping them free from the usual obstruction that results with the removal of dirt, this contractor employed a system whereby he might dig his trenches, lay his pipe and cover the completed work progressively.

This was accomplished by using the portable monorail, electric hoist system, illustrated in the accompanying line drawing. The simplicity of the design and construction makes the drawing immediately self-explanatory.

Not only does this system do away with



HOIST MONORAIL SYSTEM FOR LAYING SEWER PIPE.

the necessity of obstructing streets and sidewalks with dirt, but it cuts the cost of operation in half. This, because the dirt is handled only once instead of twice —the digging of the advance trench, the laying of the pipe in the dug trench and the covering of the completed work being done simultaneously.

The system, which is assembled in sections, trolley included, has but one requirement, that of access to electricity. This can usually be had without difficulty. By merely backing a heavy truck against one end, the whole structure is easily and readily moved along the T-rails. This is done as the work progresses. The electric hoist used on this outfit is of the "C-2" type with a capacity of 3,000 lbs., amply capable of caring for the deepest sewer or the heaviest pipe. Because of the exceptionally low first cost, coupled with the low operating and maintenance expense, this system is profitable on small as well as large jobs. The system was designed and erected by the Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.

THE "SCHRAMM" FIRE PUMP

One of the most recent and interesting developments in fire-fighting apparatus is the "Schramm" fire pump manufactured by Schramm, Inc., at West Chester, Pa.

Every community, no matter how small, has a desire and need to own a fire-fighting apparatus in order that it may be more independent of the larger towns adjacent to it.

It does not have sufficient use and is hardly in a position to equip with an elaborate unit costing several thousand dollars, but is in a position to purchase a "Schramm" fire pump costing only a few hundred dollars, which will give adequate protection.

This unit consists of a 5-h.p double cylinder, throttle-governed, gasoline engine, designed especially to meet the requirements of this outfit, direct connected by means of broad-faced, machine-cut gears to a 3x3½ in. triplex pump, delivering 4,800 gals. of water per hour at 100 lbs. pressure.

The engine is of the double cylinder, horizontal type, each cylinder having a bore of 3¾ ins. with a stroke of 4½ ins. Speed control is of special design to suit this particular engine. Operating at its full rated speed, 690 revolutions per minute, the engine under brake horsepower test, develops 5.529 horsepower.

The pump is designed for exceptionally heavy duty. The pistons are of brass and the cylinders are brass lined. This prevents both the cylinders and the pistons becoming corroded due to water laying in the cylinders when the pump is not in use. The pump is designed with extra large valves and water passages so as to obtain low water velocity.

The entire equipment is mounted on a sturdy rubber-tired truck with drawbar and equipped with a basket for holding the discharge hose. The basket is also equipped with bracket for holding the suction hose in place.

One of the main features of this equip-

ment is its light weight. Complete, but less the hose, it weighs approximately 1,400 lbs., so light in fact that it can be attached to the first available motorcycle with side car, automobile or wagon that should appear and hauled over the roughest country roads to the fire. If none of these are available, then the outfit can be hauled by two men. The light weight, compact construction and even balance, coupled with the fact that the wheels are equipped with roller bearings, make it an easy matter for two men to pull the outfit.

The size fire nozzle and the number of streams of water which this pump will supply depends entirely upon local conditions and the nearness of the water supply to the fire.

VALUABLE TRADE LITERATURE

(Editor's Note: Copies of the catalogs and leaflets here briefly reviewed may be obtained by writing direct to the addresses given in the reviews or to this magazine.)

Concrete Mixer Catalog—The T. L. Smith Co., of Milwaukee, has just published a new 48-page catalog, No. 405-C, describing and illustrating the Smith line of non-tilting concrete mixers, 4-S to 28-S sizes. Attention is directed to the efficiency of the end-to-end center mixing action and to the speedy discharge obtained by extending the discharge chute two-thirds of the way into the drum. Among the new features mentioned are the Smith water measuring tank, the use of 4-cylinder, truck-type motors for the larger sizes and a choice of either 2-cylinder or single-cylinder motors for the 7-S and the furnishing of rubber-tired wheels on certain sizes when specified. In addition to the usual specifications, dimensions, proportion and capacity table, the new catalog also contains a very practical table on weights and cubical contents as boxed for export.

Half-Bag Tilting Mixer—The T. L. Smith Co., of Milwaukee, Wis., has just issued an attractive 4-page folder describing the company's newest product—the Smith No. 375, a half-bag tilting mixer that is of the same general design and quality as the regular line of Smith tilting mixers, known to contractors for over twenty years. The folder is printed in two colors and contains a number of illustrations of both models of the 375. The condensed specifications show that model RW-1 has two bronze-bushed steel wheels equipped with clincher rims suitable for Ford 30 by 3½ pneumatic tires. Model SW-1 has four steel wheels, 24 inches in diameter, with 3-inch grooved treads. According to the company, this little brother of the big Smith tilting mixers is the best mixer value ever offered to the trade.

Steam Heating—Several bulletins of exceptional interest and value pertaining to steam heating have been issued by the American District Steam Co., of North Tonawanda, N. Y. Bulletin No. 158 tells in a very brief but most interesting way about the ADSCO System of Atmospheric Steam Heating, gives a clear view of how the System works and the results which may be expected from it. Bulletin No. 159 on the other hand gives more technical data useful to the heating contractor and architect. This book explains how radiation should be figured for the ADSCO System, also how the system should be laid out and installed. This is a valuable book for anyone who is called on to figure heating plants for small or large buildings. Booklets Nos. 20, 154, 157 and 160 cover the topic of heating groups of buildings from one central plant. Nos. 157 and 160 have a personal touch insofar as they tell about a specific installation. This information is especially interesting to Electric Light Plants who generate electricity by steam for they can utilize the exhaust steam for Central Station Heating, thereby making this expansion a very profitable investment.

Steam Sovels—A series of folders on steam shovel construction is being issued by the Thew Shovel Co., Lorain, Ohio. A folder is issued each month.

Steam Boilers—Bulletin 23-A on Uniflow improved return tubular boilers has been issued by the Lebanon Boiler Works, of Lebanon, Pa. This is a 3½x6-in., 24-page booklet illustrating and describing these boilers and their operating principles and advantages.

Wood Pipe—A catalog describing Continental wire wound wood pipe, continuous stave pipe and creo-wood flume has just been issued by the Continental Pipe Mfg. Co., Seattle, Wash. This is Catalog No. 18, 6x9-ins., 250 pages. This is a very valuable book for anyone at all interested in the subject of wood pipe and its many uses.

Tractors—"Caterpillar Tractor Performance" is the title of an exceptionally well compiled and printed catalog of 40, 8½x11 in. pages recently issued by the Holt Manufacturing Co., Inc., of Peoria, Ill.

The catalog contains a very large number of illustrations of the use of these tractors in industry and agriculture. These pictures illustrate the very wide range of economical application of this type of equipment. Specifications of the 10, 5 and 2 ton tractors are also included.

Asphalt Filler for Block Pavement—Asphalt Filler for Brick and Vitrified Pavements is the subject of the newest addition to the comprehensive set of paving booklets which have been prepared by the Asphalt Sales Department of the Texas Company. The new booklet begins its description with the arrival of the asphalt on the job in barrels and drums. Then with the aid of many illustrations it clearly and thoroughly describes each step involved in the preparation and application of asphalt filler right up to the spreading of the dressing material and the admission of traffic to the new pavement. This story of asphalt filler is presented in an attractive booklet which is small enough to tuck away in the pocket and carry about on the job. A copy may be had by addressing the Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Street Sweeper—A new product, the "Childs" motor pick-up street sweeper, is announced in a 4-page pamphlet issued by the Foamite-Childs Corp., Utica, N. Y. This sweeper is said to be of low initial and maintenance cost, durable, of one-man convenience, quiet, dustless, with automatically self-adjusting gutter broom and standard truck parts.

Steel Bunks—A 4-page pamphlet on "Tiger" steel bunks issued by Haggard & Marcusson Co., 1109 W. 37th St., Chicago. Both single and double deck, boltless, steel bunks are illustrated.

Steel Paving Guards—Street railway paving with steel paving guards is discussed in an 8½x11-in., 12-page pamphlet, issued by W. S. Godwin Co., Inc., 12 E. Lexington St., Baltimore, Md. It is claimed that these guards guarantee perfect paving in the railway area.

Stone Pulverizer—The Jeffrey Stone Pulverizer, Tpye A, is illustrated and described in Bulletin No. 142 issued by the Jeffrey Mfg. Co., of Columbus, Ohio. This pulverizer is for making road dressing, concrete stone and agricultural limestone. The bulletin is 6x9 ins. and contains 8 pages.

Power Pumps—Power pumps for the road builder, general contractor and bridge builder are illustrated and described in a small folder issued by the Barnes Mfg. Co., Mansfield, Ohio. It is claimed that these pumps last for five years.

Pipe Couplings and Tees—A circular and price list of couplings and tees has been issued by Geo. H. Snell, Attleboro, Mass. These are the "S. & S. Easy-On" couplings and tees, designed for quick repairs to the water works distribution system.

Water Testing Outfits—The W. & T. bacteriological and chemical testing outfits manufactured by Wallace & Tiernan Co., Inc., Newark, N. J., are illustrated and described in Technical Publication No. 52, issued by that Company. These outfits enable the average water works operator to make examinations of the water he supplies to the public, as often as he likes, without the services of an expert chemist.

Road Plane—The Austin Pressure Road Plane is illustrated and described in a 6x9 in. pamphlet of 16 pages issued by the Austin Manufacturing Co., Wrigley Bldg., Chicago. Special attention is given to the exclusive features of this plane. This plane is an attachment for Fordson tractors and is claimed to be the most efficient of all so-called road "finishers," "levelers" and "planers." It is designed after the principle of the carpenter's plane. Provision is made for transferring the weight of the tractor to the maintainer.

Single Stage Centrifugal Pumps—Small single-stage centrifugal pumps for motor or belt drive are described in a leaflet and in an instruction manual issued by the De Laval Steam Turbine Company, of Trenton, N. J. These pumps are made in 1½ and 2 in. sizes, and are designed for capacities ranging from 5 gals. per min. against 10 ft. head up to 130 gals. per min., against 150 ft. head. They contain few and simple parts which are manufactured to limit gages to insure interchangeability. The publications give very complete tables and instructions for selecting pumps for different conditions, and explain how to determine the proper speeds and how to select piping, valves, fittings, and driving pulley or motor to secure an efficient and satisfactory installation.

Grey Iron Street Castings—The very comprehensive line of grey iron street castings manufactured by the Wm. E. Dee Co., 30 N. La Salle St., Chicago, is illustrated and described in Catalog No. 9, recently issued. This is a catalog of 50, 4x 6½ in. pages. These are quality products, manufactured since 1855, and include

Batavia Road, Hamilton County, Ohio, "Tarvia-X" penetration in 1914. Two treatments with "Tarvia-B" practically only maintenance in 9 years.

Tarvia Maintenance Truck spreading "Tarvia-B"

Economical Construction and Economical Maintenance

What every Taxpayer desires is the *most miles* of good roads possible with the available road funds. That means economical construction *plus* economical maintenance. It means not only roads that can be built at moderate cost but roads that can be kept in good condition at small expense.

Tarvia Roads squarely meet both of these requirements.

For Tarvia Roads cost only a little more to build than plain, waterbound macadam. And with inexpensive Tarvia maintenance there is practically no limit to their life. Smooth, dustless and mudless all the year 'round, Tarvia Roads are actually improved by time and traffic. In addition to these facts the granular surface of a properly constructed and properly maintained Tarvia Road prevents skidding.

Batavia Road, Hamilton County, Ohio, shown above, is a typical example of Tarvia good-road economy. Since its construction in 1914, this road has stood up under a heavy volume of traffic. The only upkeep has been two inexpensive surface treatments with "Tarvia-B"—one in 1918; the other in 1921. Today the road is in perfect condition.

There is a grade of Tarvia for every road purpose—as a binder in new road construction; for maintaining gravel and macadam roads; for re-surfacing, patching and repairing improved roads of all types.

Tarvia
For Road Construction Repair and Maintenance

Special Service Department

This company has a corps of trained engineers, and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write our nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
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manhole and catch basin covers, catch basin inlets, adjustable inlets, gutter boxes, gutter inlets, gutter curbs, drainage curbs, sidewalk drain curbs, cemetery frames and grates, beehive grates, coal hole cover, lamphole cover, electric light conduit frames and covers, water meter frames and covers, clean out doors and frames, salamander and boiler grates, jack screws, shock absorbers and Harvey motor trucks.

Concrete Mixer Performance—The T. L. Smith Co., of Milwaukee, recently prepared publication No. 1003 which gives interesting information on the consistent performance of Smith Pavers. Many field views are shown, complete day-by-day performance data on a trunk highway, with expressions of opinion from a number of contracting and engineering companies.

Curb Construction—A 4-page letter folder entitled "A Time Study of Curb Construction," was recently issued by the Heltzel Steel Form and Iron Co., Warren, Ohio. The folder gives a very careful comparison of wood forms versus steel forms and should be of special interest to the many contractors who are using wood forms in the South.

Drainage Pipe Discharge Diagrams—The Clay Products Association, 913 Chamber of Commerce Bldg., Chicago, recently issued a pamphlet entitled, "Run-off and Discharge Diagrams for Salt Glazed Vitrified Clay Sewer Pipe and Drain Tile." This publication will be of interest to sewerage and drainage engineers.

The Austin "Pup"—The Austin Pup, a unique development among road rollers, is described and illustrated in a 4-page pamphlet issued by the Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago. This roller weighs only 3 tons, it is the first three-wheeled power roller weighing less than 7 tons. It is a very valuable addition to the road contractor's outfit. It is useful as a tractor as well as for rolling the subgrade. It is also a welcome substitute for traffic in compacting loose gravel and stone thrown on old road surfaces.

Rock Asphalt—Kentucky Rock Asphalt for new construction, reconstruction and maintenance is discussed in a 4x8½ in. pamphlet of 20 pages recently issued by the Kentucky Rock Asphalt Co., 711 Marion E. Taylor Bldg., Louisville, Ky. The production and use of this material is illustrated, and its advantages are enumerated. Special attention is given to the use of this material in resurfacing old roads.

Crane-Excavator—The Koehring Crane-Excavator No. 2 is illustrated and described in a 4-page pamphlet issued by the Koehring Co., of Milwaukee. The uses of this equipment in excavating and material-handling are described and its points of operating, flexibility and simplicity, are discussed.

Tar and Asphalt Heaters—Littleford Tar and Asphalt Heaters, paving tools and equipment for contractors and municipalities are illustrated and described in a 4x9 in. pamphlet of 20 pages recently issued by Littleford Bros., 406 E. Pearl St., Cincinnati, Ohio. This is a very complete line of equipment, particularly of maintenance equipment for the application of tar and asphalt. The catalog gives information pertaining to: tar and asphalt heaters, distributing tank wagons, patrol heaters, maintenance heaters, tool heaters, asphalt paving tools, tar and asphalt distributing pots and sand and gravel heaters and dryers.

Heavy Duty Pavers—The latest paver bulletin, giving views and specifications of the Koehring paver, was recently issued by the Koehring Co., of Milwaukee. This bulletin is printed on sheets 11x32 ins., but folds to 11x8 ins. This gives ample room for large, clear, detailed pictures of this line of paving mixers. Very interesting and instructive views of these mixers in operation are also shown.

De Laval Plant and Products—Under the title of, "Plant and Products," the De Laval Steam Turbine Company, of Trenton, N. J., has published a 24 page booklet briefly describing the single and multistage steam turbines, centrifugal pumps, blowers and compressors, and speed-reducing gears in which that concern has specialized since its establishment in 1901. In the present manufacturing plant, containing approximately 275,000 sq. ft. of floor space, all lines of manufacture are conducted on an interchangeable basis with limit gages throughout, including a comprehensive system of inspection, each part being marked with an identifying symbol and with an inspector's mark. The materials used are also inspected and tested and every machine when finished is subjected to a thorough performance test in order to determine efficiency and other characteristics. This policy, which has characterized the De Laval shops since their inception, has now become familiar to the general public through its adoption by leading builders of automobiles and similar appliances, and greatly promotes reliability and ease of replacement of worn or damaged parts.

EDITORIALS

A POPULAR FORM OF ROAD TAXATION.

A popular tax is an unheard of thing, yet the gasoline tax for highway improvement purposes arouses so little opposition, where it is properly formulated and administered and well understood, that it may fairly be called popular. A gasoline tax, or more properly a gasoline fee law, went into effect in Indiana on June 1 and, generally speaking, is being very cheerfully paid by the motor vehicle owners of this state. The tax is for road improvement purposes only; gasoline used in industry and agriculture and for all purposes other than the propulsion of motor vehicles over the highways is exempted from the tax. This makes the tax merely a fee for the use of the public roads. The fee is two cents per gallon. All the proceeds will go to the State Highway Department for use on the state roads except a half million dollars the first year and a million dollars each succeeding year, which will be returned to the counties for use in county highway improvements.

The law is being contested in one county, but there is little doubt it will be held valid in the courts. Outside that one county there is no opposition to the tax. Motorists generally say they don't mind paying the tax as long as the money goes for better roads. They regard it as an investment which will pay big dividends, as the highway system develops, in the form of reduced operating and vehicle upkeep costs.

Now that the tax is in successful operation it is interesting to recall the mighty wave of opposition which its opponents succeeded in stirring up when the measure was pending in the legislature. One then gained the impression that if the bill became a law many would leave the state, while others would remain to wage a revolution. It was loudly asserted that the cost of collection would run into the hundreds of thousands of dollars and that a small army of state employes would be required to collect the tax. That was the prophecy. The fact is, as stated, the tax is as near popular as a tax ever was or ever can be, and the annual cost of collection will not exceed $5,000. Not over two people will be required to collect it and they probably can find time for additional work. This is due largely to the splendid co-operation of the gasoline wholesalers, led by the Standard Oil Company. "Much Ado About Nothing" would be an appropriate name for the comedy staged in the vain effort to prevent this measure from becoming a law. That is, it is comparatively nothing to the individual motorist. It will cost him less than one dollar a month on the average. The gross income from the tax will exceed $3,000,000 per year.

Over half the states now have a gasoline tax. Others have considered it. In Michigan, where the gas tax was defeated, rather a sorry mess has been made of highway financing for the present.

The principle underlying the combined registration fee and gasoline tax is sound and is simply the "readiness to serve" charge plus the metered service charge, proved sound and equitable after generations of experience in water, electric light and illuminating gas rate-making. The license, or registration fee, is the "readiness to serve" charge; the roads are ready to serve when wanted and the vehicle owner is required to pay this basic, or minimum, charge. Additional payment is directly proportional to the use of the road, as the consumption of gasoline not only measures the travel of a vehicle, but to a large degree measures its destructive action on the road surface as well.

This form of taxation for road improvement purposes deserves to be, and probably soon will be, universal. It is growing in favor throughout the world.

EXTENT OF THE HIGHWAY BRIDGE PROBLEM.

The nature and extent of the highway bridge problem is well illustrated by conditions existing in the state of Indiana on the state highway system. On

the present state highway system, which is 4,500 miles in length, fully 10,000 bridges and culverts require either reconstruction or replacement to care properly for present and prospective traffic needs. Probably half of these structures will accommodate but a single line of modern traffic; some are too narrow and others too weak to carry two lines of traffic. The marking of such bridges so as to warn the public as to their safe use is a big job in itself. Many of these bridges are old and most of them were built when public roads were 9, 10 and 12 ft. wide with bridges 14 ft. wide. Few of the older bridges were designed to care for more than a 5 ton load, while today loads range from 8 to 15 tons and occasionally reach 20 tons.

It is, of course, both a physical and financial impossibility to complete such a bridge building program quickly. Such a program must extend over a period of 15 or even 20 years on the state highway system. Even more time will be required to modernize bridges on other roads. Probably this condition is typical of those to be found in all the principal states. The public must be taught patience in connection with this stupendous problem, if we are to avoid the sort of dissatisfaction and criticism which will hamper the work of the highway departments, and must be taught to approach bridges with care as many are unsafe for fast or heavy traffic. Many accidents due to narrow bridges and to those of limited capacity will be avoided when the public learns to cross bridges cautiously.

Rebuilding the highway bridges of this country is not a summer's job, but will require the best working years of many men's lives. Our highway bridge builders are doing a splendid job, building for future as well as present needs.

SUPPOSE THEY ALL QUIT?

Not long ago salary increases were sought by, and on behalf of, certain employes of the city of Indianapolis, including a number of engineers. Department heads made honest efforts to secure reasonable salary increases for their deserving subordinates. The effort was worth while, for some increases were granted; many of these were purely nominal, amounting to a hundred dollars a year or less, and all were far short of the recommended amounts. The City Council merely took cognizance of the requests and sought to satisfy them by minimum concessions. All this was quite ordinary.

An unusual commentary on this effort of municipal employes to make an adequate and honest living was supplied in an editorial in a local newspaper. After lengthy comment having to do with "the taxpayers' money" the editorial concluded with the observation that in practically all cases the municipal employes knew what their pay would be before they accepted their jobs and if they didn't like the pay they could quit.

Of course they could quit and we often wonder why they don't. What if they did? The majority of municipal employes could easily be replaced, but this does not include engineers. So far as the engineers are concerned we do not hesitate to say that practically all of them, at least the subordinates, would better themselves greatly and quickly if they left the municipal service forthwith. But what of the public? The public would suffer and bnowing this the engineer "sticks" because of his sense of public duty. It is becoming a serious question, however, whether he has any right to continue his thankless sacrifices when practically all classes of society who have brains enough to look after their own interests take mighty good care of number one.

Engineers in public service are not going to improve their fortunes very much by such minor increases as they are able to secure from time to time as individuals. These tiny increases are grudgingly bestowed and are likely to be withdrawn at any time. Sometimes increases lead to later reductions which are greater than the increases were, so that the second condition of the engineer is worse than the first. No, these efforts are unavailing.

Either the engineer in public service must regard his position as a stepping stone, as a means to a more profitable end, or as an opportunity, for one of independent means, to render unselfish public service, or he must show the public the value of his services and demand compensation worthy of his skill, making clear, meanwhile, his determination to abandon the public service in due course if his efforts are not properly rewarded. So far as the public is concerned it will never appreciate the public service engineer until it knows the worth of his services and is made to fear the loss of them.

Speaking of newspapers, as we were a moment ago, it is interesting to observe that the only economy the newspaper preaches is economy in public expenditures. It is seldom, indeed, that a newspaper preaches economy in private expenditures. If the newspaper urged it readers to buy a cheaper car, or to make the old car to another year, or to buy inexpensive clothing and house furnishings, to get along without a piano or a phonograph, to cut out the vacation trip, and, above all, to abandon the mad orgy of senseless spending at the Christmas season it would cause its readers to save such great sums of money that taxes would appear insignificant in comparison. But it doesn't do these things as the advertiser who supports it would never stand for the preaching of true economy in private purchases. Therefore the paper rants at public expenditures, appealing to the miserly instinct of the individual in respect to the tax dollar while tempting him to spend his dollar in a thousand other ways from which he may derive less benefit.

Among the most conspicuous sufferers from this indefensible practice are the expensively-educated, public-money-saving engineers. How much longer are they going to stand for it?

PRESENT ASSESSMENT OF A FUTURE BENEFIT

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, 22 N. Carrol St., Madison, Wisconsin.

Two very interesting problems have been presented to me recently in the matter of making an assessment for a benefit that will not accrue to the assessed until some future time. The first one to come to my attention was the problem of arriving at the amount of the benefits which would accrue to a village by constructing a drainage ditch at the site of the sewage disposal plant.

A few years ago the village of Sun Prairie, Wis., constructed a sewerage system which included an Imhoff tank so located that the effluent was discharged into a very shallow ditch in a marsh adjacent to the plant. The natural flow of water in the drainage ditch was very small, possibly three times the flow of sewage which was about 90,000-gals. per day, based on the water consumption.

The effluent from the plant polluted the waters of the ditch considerably but not enough to cause much protest so that this is not a direct factor in the immediate construction of the new ditch. This proposed ditch is to be constructed under the Wisconsin Farm Drainage Law and is under the jurisdiction of the county commissioners.

The principal purpose of the district is for benefits to agricultural lands. By the construction of this ditch at a depth of 9 ft. it would not only cause a larger flow of ground water in the ditch, but it would make it possible for the village to construct filters that could be operated by gravity. Such construction would avoid the necessity of a sewage pumping station and would save the annual cost of operation which is estimated to be at least $250 per year when the flow has increased to 144,000 gals. per day. This low cost is due to the low power rate for electric current to the small quantity pumped and the low lift.

There is no immediate demand for the further purification of the sewage which might cause the expense of constructing a filter together with a pumping plant. However, it is certain that within 10 to 20 years either the State or Federal Government will require the purification of all sewage to such a stability that it will not cause a nuisance or be detrimental to health. If we were to assume that the annual interest on the investment in a pumping plant was $300 and the annual cost of pumping was $250 and these amounts capitalized at 5 per cent, the amount that the village could afford to spend to avoid the construction and operation of a pumping plant would be $11,000.

To assess this amount to the village for a benefit that will accrue at some future date is obviously unjust. Neither is it fair to the district paying for the improvement, to give this relatively large benefit to the village simply because they don't need it now.

Some assumption must be made as to the time when the village would have to purify its sewage further and what effect the construction of the ditch would have in further putting off that time. It would be extremely fair to the village to assume that these two periods would each be 10 years or a total of 20 years.

For every dollar that the village might lay aside now would at 5 per cent compound interest be worth $2.65 at the end of 20 years. If this benefit is worth $11,000 to the village in 20 years it is now worth that sum divided by $2.65, or $4,-

150. This sum should then be the basis of benefits assessed to the village. The actual cost of construction being about 35 per cent of the benefits the actual cost to the village would be $1,452.50.

The other problem was a similar one but less difficult. Under the Wisconsin Law Chapter 62.18 a city or village can pay for the cost of a sewerage system by the city at large by the front foot or by sewerage districts on the basis of the benefits derived, or by a combination of any of these methods. At Milton, Wis., it is proposed to pay for the sewerage system by an assessment of 65 cts. per front foot and by a district tax of $20,000 to be spread over a period of 10 years by the issue of special improvement bonds. The assessments of benefits was made in proportion to the present assessed valuation. It is proposed to build about 80 per cent of the system at this time which will consume all of these funds.

Later, possibly 5 to 10 years from now, extensions will be needed on four or five streets leading into the country. The question has arisen, "Should the property not now receiving the full benefit of the system help to pay the principle and interest on these bonds; and if so, should their valuation remain as the others, or should it be cut down and how?"

In this case it was assumed that certain properties would have sewers in 5 years and certain others in 10 years. Their valuations were cut down in proportion to the value of a dollar at compound interest for these periods. While no one can say or prove that these times or this method is exactly correct, it is, however, a sound basis for adjustment and no doubt would receive better consideration in a court than would a mere guess without a reason for the guess.

DETERMINING THE PROPER EQUIPMENT FOR PUMPING STATIONS.

By Arthur L. Mullergren, Consulting Engineer, 555 Gates Bldg., Kansas City, Missouri.

The objective in the designing of a pumping plant is the selection and installation of such equipment as will give the most reliable and adequate service at the lowest possible cost, taking into consideration all fixed charges and operating costs. The modern pumping station is similar to the electric power station in that both are called upon to deliver essential commodities continuously and adequately at a minimum of expense. The pumping station is somewhat different in that reliability of service is the prime requisite as continuous service must be given at all times even at a sacrifice of economy. However, economy never has to be greatly sacrificed in a well designed station.

Three Principal Factors

The three principal factors to be considered in the design of a pumping station are in the following sequence: (1) Reliability; (2) Adequacy; (3) Economy.

Reliability can always be obtained by the selection of the best types of equipment known and by duplication of all parts throughout the installation. Adequacy can always be obtained by using liberal sizes of equipment and appurtenances. The economy, however, is affected by the first two factors, in that unnecessarily expensive equipment might be selected for the particular installation and avoidable duplication made, as well as by installing equipment too large for the particular requirements.

There is a happy medium that can be reached by properly proportioning and selecting the various equipment for each particular installation that will give amply adequate and reliable service at an economically satisfactory annual overall cost. Therefore, in the designing of a pumping station, the three factors mentioned above should be carefully weighed in the determination of each piece of equipment that goes into the station.

Inasmuch as the overall economy of a station depends upon delivering the required quantity of water at the required pressure with the least possible fuel and labor charges in addition to the fixed charges, it is important that careful consideration be given the various component parts of the station equipment so that the completed station will give the results desired. In some instances it is impossible to secure a highly economical installation, due to location of plant and space requirements. A water pumping plant must always be located with regard to the available supply, regardless of the desirability of the location from an operating standpoint. The location of a plant generally has some effect upon the type of equipment selected and consequently each particular location requires careful consideration. When considering the reconstruction or rehabilitation of an existing plant, a greater overall plant and system

economy may be secured by selecting a different site. In some cases it is possible to have a choice of a half dozen different locations from a water supply standpoint and in such cases, the determination of the site can be made from a purely operating standpoint.

Vertical Triple Expansion Crank and Flywheel Pumping Engines

There has been marked improvement of the design of pumping machinery and power station equipment in the last few years. Up until very recently, for very large pumping stations, the vertical triple expansion flywheel pumping engine has been pre-eminent from an economic and mechanical standpoint. This type of engine under favorable steam and water conditions has reached a duty exceeding 200 million foot pounds per thousand pounds of steam. These engines have been very reliable and the maintenance cost very low. However, they require very expensive buildings and foundations and the investment is very high. The installation of such engines is prohibitive in the smaller plants, owing to the very high fixed charges. The annual fixed charges on this type of pumping engine will exceed $700 per million gallon daily capacity.

Marked Improvements in Steam Turbines and Centrifugal Pumps

With the very marked development made in steam turbines in the last few years and the improvements made in the design of the centrifugal pumps, the steam turbine driven centrifugal pump has reached an overall economy that will exceed the vertical triple expansion flywheel pumping engine where favorable steam conditions can be obtained. There is no question now as to the reliability of the steam turbine, as the general electric power stations use this type of prime mover exclusively and have used them for a sufficient time to thoroughly demonstrate their usefulness as a reliable and economical source of power. There is no question as to the reliability of the centrifugal pump and the designers of these pumps have now increased the efficiency of them to a very high state,—reaching as high as 86 per cent.

One of the difficulties formerly encountered in the turbine driven centrifugal pumping unit was the gearing used to reduce the pump speed to a satisfactory point. The double helical reduction gear now employed for this purpose has overcome this difficulty, as such gears have an efficiency of 98½ per cent and operate with very little noise and maintenance and apparently have a life equal to the unit.

The steam turbine is admirably adapted to high steam pressures and high superheat, as well as a high vacuum. With the increasing tendency towards higher steam pressure and higher superheat, the turbine pumping unit will naturally benefit in economy to a greater extent than the reciprocating type of pumping engine; consequently, there will be an improvement in the duty of the turbine pumping unit as improvements in the boiler plants are made. Materials capable of withstanding a total steam temperature of 750 degs. Fahrenheit, are commercially used in turbines, boilers and piping, and this temperature seems to be about the commercially practicable limit at present, although there is considerable research work being undertaken to develop materials capable of withstanding much higher temperatures. The highest duty probably reached so far under an actual operating test by a turbine centrifugal pump was that of a 30 million gallon centrifugal pumping engine at the Mount Royal Pumping Station, Baltimore, Maryland. The duty reached by this engine on test was 170 million foot pounds per thousand pounds of steam, when delivering water at the rate of 45 million gallons per day at a pressure of 180 ft. with a steam pressure of 172 lbs. superheated 53 degs. Fahrenheit and a 28.9 in. vacuum. The city of Omaha, Nebraska, has recently contracted for the installation of a 50 million gallon per day 280 ft. head steam turbine centrifugal pump and the manufacturers have guaranteed a duty of 189 million foot pounds per 1,000 lbs. of steam based on 250 lbs. steam pressure at 150 degs. Fahrenheit superheat and 70 degs. cooling water. This duty is exclusive of the condensate pump and the whirling water pump for the hydraulic air ejector, which two pumps are direct connected on one shaft to a 24 brake horsepower steam turbine operating non-condensing. The duty included, however, all other auxiliary equipment used by the pump, condenser and turbine. The non-condensing steam turbine for driving the auxiliaries mentioned is used to secure a proper heat balance in the station. Consequently, the total station duty will not be affected and may possibly be improved.

Trend Toward Turbine Driven Centrifugal Pump

In most of the larger pumping stations

made in the last year or so, the steam turbine driven centrifugal pump has been installed. The tendency is decidedly towards the use of this type of equipment, and in view of the very recent marked improvements in economy and design, together with the improvement in economy that can be made by the use of higher steam temperatures, I predict that in less than ten years, the reciprocating type of pump will have a very limited field, and the number used will be negligible. Centrifugal boiler feed pumps, both steam turbine and electric motor driven are quite common now, and there has recently been developed a satisfactory small steam turbine for stoker drive.

The large central electric power stations have made great improvements in the overall plant economy. This improved economy has been secured largely through the improvements in the boiler plant equipment. An overall plant thermal efficiency of 18 per cent has been reached, and it is expected 20 per cent will be reached shortly.

Increasing Boiler Plant Efficiency

The boiler plant has always been and is yet the least efficient part of the pumping station or the central power station, and power plant engineers are making a great effort to improve the efficiency of this part of the plant. Larger boiler units are being installed with higher steam pressures and higher superheat. Furthermore, the tendency is to operate the boilers at much higher ratings, which keeps down the investment and fixed charges and the thermal efficiency of the boiler is not seriously affected. The central station engineers have been endeavoring to secure as near as practicable a perfect heat balance in the station, which of course, increases the overall plant economy. This is attained by utilizing the greatest possible number of heat units of the fuel and returning the condensate to the boiler at the highest possible temperature.

In a recent boiler installation made in a central station, the furnace walls were lined with cast iron blocks surrounding steam tubes through which the boiler water circulated. It is expected that the additional heating surface furnished in this manner will give a much higher overall boiler efficiency, due to the fact that more of the heat units of the fuel will be utilized. It is furthermore expected that the furnace maintenance expense will be reduced over the regular fire brick lining which is always a source of expense.

The judicious use of economizers has also considerably increased the boiler plant efficiency. Recent tests indicate that greater plant economy can be secured by bleeding the main turbine units at the lower stages for feed water heating than by using small steam non-condensing auxiliaries for this purpose; in fact better overall results were obtained by bleeding a sufficient amount to secure the required feed water temperature than by using economizers and steam driven auxiliaries or house turbines. This bleeding also relieves the lower stages of congestion.

Either electric driven or waterwheel driven auxiliaries can often be used to a better advantage from an installation as well as an economic standpoint. In water works stations the waterwheel driven auxiliaries with hydraulic air ejectors, returning the cooling water to the suction of the main pumps, offer simplicity and economy. However, only the very largest pumping stations would warrant a boiler plant installation similar to that used in the best type of central stations, but in many cases it would be possible to secure a greater overall station economy by the use of central station methods and equipment adapted to the particular condition.

Boiler Room Meters

There are now on the market meters for the boiler room that will record fairly accurately the various operating conditions of the boiler plant, thus making it possible to check up any unusual loss occurring therein. A modern boiler room should contain all such meters as will enable the operating engineer to tell the condition of his combustion, water temperatures, output and any defects in his equipment. While we are at present getting good thermal efficiencies out of our individual boiler plant equipment and the prime movers, there is room for considerable improvement in the overall plant economy. A gain of a few per cent in efficiency in each part of the plant may mean a considerable reduction in the total annual expense. Consequently, when it is possible to make a small gain by improvement to any part of the plant equipment, it is advisable to do so, as the various improvements made regularly, will ultimately make an excellent showing in the plant operation.

The Station Considered as a Unit

In the determination of the equipment

for a pumping station, there has been a tendency to select a very highly efficient pumping unit sometimes without regard to the adaptability of the unit for the conditions under which it will operate, and particularly without regard to economic considerations, and at the same time the boiler plant equipment and auxiliaries are selected with very little thought. The pumping station should be considered as a unit and all equipment entering into its construction should be carefully selected with regard to the adaptability and economy of the various parts with respect to each other and to the whole. Much publicity has been given at times to the very high thermal efficiency reached by some pumping units, and in some cases the overall thermal efficiency of the plant has been commented upon. Our goal has apparently been to secure a high duty per B. T. U. If the efficiencies of some of these plants had been measured in duty per dollar of annual charges, they probably would not have made such a satisfactory showing. After all, the duty per dollar of annual charges is the true measure of efficiency of the pumping station, and in the selection of the equipment for a station, this should be the basis for the determination.

Since the development of the central station to its high degree of efficiency and the extensive transmission systems emanating from such stations, there are conditions where electric motor driven pumping plants would show a considerably higher duty per dollar of annual charges than a very highly efficient steam plant. This is particularly true in the smaller installations and where electric power is available at reasonable rates. Where synchronous motors can be used, central stations are offering attractive rates to the water pumping plants, as this type of motor assists in correcting the power factor of the transmission system, and the hours for pumping can be, in a great many cases, arranged to suit the central station.

Motor driven centrifugal pumping units have been installed that have shown a combined overall efficiency of 82 per cent, which is a very good showing when we consider that the mechanical efficiency of a vertical triple expansion flywheel pumping engine is about 93 per cent. Reliability of service is one of the principal reasons that electric drive has not been more generally adopted. However, with the duplicate or loop transmission lines and interconnected central stations, practically as great a reliability as the self-contained plant will be secured. Furthermore, emergency equipment operated independently by an inexpensive steam or oil engine installation may be provided, thus insuring absolutely continuous service, and by carrying the fixed charges on this emergency equipment together with the small amount of operating expense that may be incurred in its operation, plus the regular operating expenses and fixed charges of the electric driven plant, the annual charge of the entire installation may be considerably under the annual charge of a highly efficient steam plant. Some of the larger central stations have their plants installed at the coal mines and own these mines, consequently their fuel costs are not subject to the wide fluctuations of the average water pumping plant, and as a result, by considering the annual operating and fixed costs over a period of years, the purchase of electric power will in a great many instances show up considerably under that of producing the power. Superpower plants and systems are being built and the greater the system, the greater the advantages of purchasing power over producing it with isolated plants. The pumping stations located in these superpower zones may well look to electric driven equipment, or a composite electric and steam driven plant so arranged and operated as to take advantage of the low power costs, low fixed charges, flexibility and simplicity of operation.

The Oil Engine

The Diesel type oil engine has been developed to a very high state of efficiency and reliability and in certain localities, this type of pumping plant would probably make an unexpected showing, insofar as the annual costs are concerned. The investment in this type of equipment is very high, but the fuel economy is high,—such engines reaching a thermal efficiency of 35 per cent, and in localities where coal is very expensive, and electric power is not available at satisfactory rates, it would pay to investigate the feasibility of such an installation before definitely determining upon any type of plant.

In stations having a daily capacity of 10 million gallons and above, and with coal costs around $6 per ton, the high pressure steam driven centrifugal pump will ordinarily show the best duty per dollar of annual charges, over any other isolated type of plant. In plants below

this capacity, each particular installation would require a thorough investigation and a careful balancing of all costs, before a definite type of plant could be decided upon. It is generally recognized that in plants of three to five million gallon daily capacity, that the cross compound flywheel pumping engine will make the most favorable showing. In regard to thermal efficiency, this may be very true, but it would not hold in every case if the duty per dollar of annual charges was considered.

In conclusion I might say that definite annual cost data on each type of plant for different conditions would be of considerable value in supporting the foregoing, but there are so many different conditions and so many different types of plants that could be considered for each particular condition, that it would require considerable space to present it. The point that I wish to emphasize in this paper is, that in the selection of the various equipment entering into a pumping plant, that instead of endeavoring to select the individual plant units having the highest thermal or mechanical efficiencies, or even securing the highest total plant duty on a heat unit basis, that the completed plant should give the highest duty per dollar of annual charges, in which would be included all operating expenses, maintenance, interest, depreciation, insurance and any other fixed costs, and at the same time taking into consideration the reliability, adequacy and future growth of the plant.

The foregoing paper was presented at the recent annual meeting of the American Water Works Association.

RESURFACING RIGID PAVEMENT WITH BRICK AT BETTENDORF, IOWA

A practical method of economically salvaging rigid pavements that have been worn to a condition of extreme roughness, has been adopted at Bettendorf, Iowa, a suburb of Davenport. A hard surface pavement that was laid eleven years ago, but which has been in bad condition for the last seven years, is now serving a useful purpose as a base for a new pavement. City Engineer N. H. Tunnicliff, has solved the problem of repairing the pavement by resurfacing it with vitrified paving brick and thus making practically an entirely new pavement of it. The rebuilt pavement will have the many advantages that an asphalt filled brick pavement is recognized to possess such as flexibility, durability, long life, and low repair costs.

The road now being paved is part of the main artery out of Davenport, leading northward along the west bank of the Mississippi river. About three miles from the heart of Davenport, the road passes through Bettendorf, a small municipality quite widely known for the car shops which are located there. Other plants are also located in this manufacturing city.

In Bettendorf the street is about 50 ft. wide between the curbs and carries two street car tracks. The roadway on each side of the car tracks measures approximately 18 ft.

City Engineer Tunnicliff specified a 3-in. vertical fibre, lugless brick pavement, asphalt filled by squeegee method. The specifications are being successfully complied with in the requirement that no more than a paint coat of filler is left on the top surface of the brick. Torpedo sand is applied after the filler is placed.

The brick surfacing was specified to be laid on 1-in. cement-sand bed, 1:4 mix, spread over the old 6-in. concrete pavement, which was to remain as the base for the new street. Extra material is used to fill depressions in the old base.

The contract was let at $2.425 a square yard to the Central Engineering Co., of Davenport, with the stipulation that where extra material was required in cracks, holes, etc., the additional amount would be paid for at $10 per cu. yd.

The total pavement includes approximately 28,000 sq. yds. Brick furnished are of less than 22 per cent loss on ratler test.

When the street car tracks were relaid several years ago, it was anticipated that the old pavement would eventually be surfaced with brick. Thus the tracks were laid higher than the level of the pavement.

TACKLING THE STRAY CURRENT PROBLEM

By C. E. Schutt, Consulting Electrical Engineer, Krehbiel Co., 730 W. Monroe St. Chicago, Ill.

When man discovered fire he soon learned to make use of it. He learned also that it was capable of doing great damage if left uncontrolled. It is in a somewhat similar position that man finds himself with regard to electricity. It is

a destructive agent when left uncontrolled.

It has long been known that a current of electricity in passing from a metal into an electrolyte does so by carrying a portion of the metal along with it. Much of the research done in regard to this action and its characteristics has been in the line of industrial applications. Numerous processes have been developed for electro plating, and for electrical separation and recovery of metals and around these processes great industries have been built.

The same kind of work is being done by stray currents that flow in pipes and other metal structures buried in the earth. This work is demonstrated by the rapid destruction of metallic bodies located at certain points in the earth where the electric current flows from such bodies into the earth on its way to the power station.

When a metallic body is buried in the damp earth or is placed in contact with the earth there is present all the mechanical apparatus necessary to produce electrolytic action. All that is necessary actually to produce this action is to force an undirectional electric current from the metallic body into the surrounding earth. The amount of metal carried away by the current will depend upon the quantity of current flowing. The metallic body will gradually disintegrate, and there will appear, in the case of iron, a deposit of rust or iron oxide. This process is known as electrolytic corrosion. In practice conditions favorable to such destructive action, is found where pipes, cables, bridges and structural steel are in contact with the earth in such relation to a grounded power circuit that current tends to flow from the conductor into the metallic structure and then from the structure again into the earth. It is at the points where the current leaves the metal that the metal is eaten away.

There have been many theories advanced regarding damage to underground metallic structures by electrolytic action. So many of these theories have been so biased by the point of view of the individual that they are of little practical value in the solution of the problem of minimizing the damage. Other theories are comparable to some of the early theories of fire. One of these theories which held a strong position was that since fire went up there must be a lot of fire above the earth. Proof of the theory was that the Gods threw it down in the form of lightning so that man would have it to use again. Not so bad in the way of an argument and it compares favorably with many theories elucidated today without being able to get at experimental facts to substantiate them.

It is now well recognized that electric currents flowing in the earth and in grounded bodies are a source of very great damage. Experimental work has been carried on by very responsible organizations and data is available upon which to intelligently attack the problem from an engineering standpoint. Many of the false notions are disappearing and a rational method of approach is taking its place.

The money spent on fire prevention and fire insurance greatly exceeds the loss by fire in our cities. If these measures were not taken cities would be burned to the ground as fast as they could be built. The money spent on the control of stray currents is on the other hand almost negligible when compared to the damage and loss. The damaging work of corrosion goes on very quietly, and does not make a display like a fire, but the same corrosion has allowed many a fire to become spectacular by the breaking of weakened water mains under fire pressure.

It is safe to say that there is today no known panacea for all the ills of stray electric currents, that is, there is no one remedy that can be applied to all cases. In fact a remedy that is practical and may give the required measure of relief in one case may greatly aggravate the trouble in another case which appears to be identical. Again remedies that serve to protect one structure may cause added hazard to neighboring structures. Cases have been noted by the writer where remedies have been applied to protect one pipe system which has produced bad conditions for other underground structures in the same territory. Yet a company can not be criticized for protecting its property in the best possible manner. Like conditions will continue to exist and all utilities will suffer so long as each fellow stands in his own back yard and tells the other to get off the earth.

Each of the utilities is quite as essential to a city as any other utility. A city could not long exist without any one of them. If each interest cares for its problem independently then each is partly

undoing the work of all the others and a condition arises where money is being spent in producing systems that afford relief only temporarily. One can readily imagine the confusion that would arise where a cable company in a given territory has applied a drainage system to the cable sheaths, a pipe system has been provided with insulating joints and the railway company then installs a track drainage system. The three systems are in many ways in conflict.

A great many cases of very aggravated electrolytic trouble can be greatly relieved by very simple and inexpensive means when once the source and exact nature of the trouble is known, but too often the nature and seat of trouble is guessed at and the wrong remedy is applied. This is an expensive way of going at the problem for not only is a company likely to spend a lot of money uselessly but the damage is quite likely to be increased.

United effort on the part of all interests including the offenders and the injured would go a long way in simplifying the problem of controlling stray electric currents. Where such interests can meet in a spirit of live and let live they will find that everything can not be done to the exact liking of one party, but that with a certain degree of tolerance very acceptable results can be brought about and stray currents from any source can be so controlled that very little damage will result.

MUNICIPAL TEAM WORK IN INDIANAPOLIS

By Frank C. Jordan, Secretary, Indianapolis Water Co., 113 Monument Circle, Indianapolis, Ind.

We hear a great deal about the popular latter day mysterious and intangible thing called "public relations." We listen to, and read, long and expert papers on the subject, but down under the surface we gloss over with phrases, is the undeniable fact that public relations, so called, consist of nothing more nor less than neighborliness. The water works operator who is a good neighbor to all his community, who treats his neighbors fairly, serves them well, charges them properly and carries his share of the community load in all respects never has one of these lately discovered public relations problems.

The utility operator who works with his city officials as one neighbor with another, never has such a problem. If he is acquainted with these city officials, as one neighbor knows another, it follows that the officials will know his problems of operation and will sympathize with him as one neighbor with another. It is only when we keep away from the officials, and behave as perfect strangers to them, that difficulties arise.

There may be some who will say that it is well to keep a respectable distance between city or state governmental officials and the utilities. The trouble with this theory is that this distance leaves space that may very quickly and readily become filled with misunderstandings, mistrust and even enmity.

It all simmers down to this: The problems of the utility, which are service and rates, are community problems. The utility cannot solve either one by itself; neither can the community, through its city or state officials. Both problems are bigger than either the utility or the officials. They must be solved for the common good of both; therefore, the thing to do is to maintain friendly and neighborly relations towards each other. Such neighborliness tends towards Municipal Team Work.

Fire Department Relations

In an attempt to bring about efficient Municipal Team Work in the city of Indianapolis we became neighborly with the various city departments and the results have been most gratifying. We held neighborly conferences with the Fire Department, and these have resulted in a more efficient public fire service. In a neighborly way we invited the Fire Chiefs, Fire Captains and Lieutenants to visit our plants and they accepted our invitation. They evidenced great interest in the operation of our pumping units, boiler room, etc., and a great majority of them confessed that it was their first visit to any of our properties.

We returned their call and many of our men had to confess that it was the first time that they had had the opportunity of receiving first hand information in regard to the trials and tribulations of a city fireman. This neighborliness has made their problems our problems, and our problems their problems. In one of our neighborly conferences, the question of decreasing our fire loss came up for consideration and it was only natural that we should join hands in a Fire Prevention program and the Indianapolis Fire Prevention Campaign was the result of these neighborly talks.

Fire Prevention Campaign

During the first 18 months of our Fire Prevention Campaign we held neighborhood meetings in every section of the City, and through the instrumentality of moving pictures, addresses and contests, the value of fire prevention measures was impressed on the minds of the Indianapolis public and they are now evidencing an exceptionally fine spirit of co-operation as the result of these little meetings when two or three hundred neighbors gathered in a fire engine house or public school building to plan for a cleaner and safer Indianapolis. At this time our attention is largely centered on a Clean-Up and City Beautification program and a campaign for the Elimination of the Wooden Shingle Roof, and we are receiving most satisfactory support from the great majority of Indianapolis citizens. During 1922 the building commissioner issued approximately 4,000 re-roofing permits, and at the present rate this number will be almost doubled during 1923. In this great campaign for a cleaner, safe and healthier Indianapolis, we have witnessed Municipal Team Work second to none in the history of our City.

Insurance Reclassification

History has shown that it is rather unwise for one neighbor to point out the defects in another neighbor's household, and bearing this fact in mind, we called in the National Board of Fire Underwriters to make a most careful study of the fire and water departments and we then joined in a neighborly effort to eliminate these defects which were brought to our attention by the exceedingly efficient gentlemen from the National Board's office. A movement is now on foot to give Indianapolis a re-classification in its insurance rating, and our citizens will profit because of the Municipal Team Work in building up the public fire service.

Board of Health Relations

We held some very pleasant conferences with the City Board of Health, and in a consideration of the physical conditions in Indianapolis we discovered that many of our citizens were under-privileged in that they did not have the privilege of living in modern homes equipped with bath, toilet and other modern sanitary conveniences. In company with city officials, we visited several of these properties and found that many of these under-privileged citizens were very desirous of making their properties modern but that their financial condition precluded such a transformation. The Board of Health gave consideration to the enactment of very stringent measures, which would compel the installation of sanitary conveniences. A brief consideration of this proved that it would not be the neighborly thing to do unless the City was able to show that these conveniences could be installed without considerable financial embarrassment to these under-privileged citizens. A few more neighborly conferences were held and a plan was formulated under which plumbing is being installed on the payment plan and a sanitary program of vital importance to the health of Indianapolis is being carried through with practically no friction whatsoever.

The City Health Department is morally obliged to rid the city of disease breeding places, and the Water Department must bear a share of the Health Board's obligation in this matter. It is, therefore, of vital importance that some financial arrangements be made under which every citizen may have the benefit of thoroughly sanitary quarters. The payment, or budget plan, is being utilized by quite a number of our citizens and we have found that an advertisement of the payment plan of plumbing installation is all that is necessary to bring people to the plumbing supply house. and in many cases they are able to take care of the financial arrangement without resorting to the payment plan. This budget plan is working very satisfactorily and is serving a great purpose.

Water Rules and Regulations

In one of our neighborly conferences with some of our patrons, some question was raised in reference to our rules and regulations. The friendly advice of the Public Service Commission was sought and as the result of some further conferances a committee, consisting of bankers, manufacturers, lawyers, club women, water works men, college professors and other citizens to a total of 25, met, in a neighborly way, to formulate water works rules which would be fair both to the utilities and the balance of the public. This committee has held several meetings and these rules are about ready for submission to this Association and to the Public Service Commissions throughout the country. The fairness of these rules is an indication of the public's desire to be fair when the utility presents its case in the right manner.

In our program of co-operating with the Board of Public Works in the up-building

of our City, we have been called upon to make very large expenditures in water main extensions, many of which are not paying investments but which are of inestimable value to the Indianapolis citizens. In carrying out such a program, entailing large expenditures, it is necessary for the state and city authorities to pursue a broad-gaged policy.

In an attempt towards neighborly cooperation with the Park Board we have done a considerable amount of work in beautifying the grounds around our pumping stations and we are looking forward to the day when every part of the water company's property will be a beauty spot and will mould itself into the great plan of city beautification.

Public School Relations

We have most friendly relations with the school children and the publicity which they have given us is of tremendous value. Every pupil in the upper grades is required to write an essay on the public water supply of our City, and during the course of the year a great many of the classes visit our filtration system and pumping stations and very little of interest escapes their notice. We recently furnished the school children with pamphlets descriptive of our property and these pamphlets are being utilized as the foundation for thousands of essays. A great many of our new patrons volunteer the information that a school boy or girl in their home has insisted upon having sanitary conveniences in the home and in this, and other ways, it has been demonstrated to us that the water company can have no more valuable asset than the good will of the school children of the city.

Our City is blessed with an exceptionally large number of civic and commercial organizations, the records in the local Chamber of Commerce showing a total of more than one hundred groups of people organized for the purpose of up-building the City. One of our many trips of inspection included representatives from 92 of these organizations and no publicity expenditure made by our Company has been productive of better feeling than this inspection trip when men and women from every section of Indianapolis spent a full afternoon and evening in an inspection of our properties and a consideration of the future development of the public water supply.

It has been gratifying to find that our attempts at neighborliness have been reciprocated in a greater degree than we had any reason to expect. Almost without exception our citizens have assumed a most neighborly attitude and there is being carried forward a Municipal Team Work which is resulting in great good to our City.

The foregoing is from an address by Mr. Jordan before the recent annual meeting of the American Water Works Association.

WATER WORKS PUMPING STATION DESIGN

By Charles B. Burdick, of Alvord, Burdick & Howson, Engineers, 8 South Dearborn St., Chicago, Ill.

It is the purpose of this paper to outline the general principles of pumping station design and to cite a few examples of recent construction, referring more particularly to the buildings for housing water works equipment.

The average water works involves an investment not less than $35 per capita or say $3,500,000 in a city of 100,000 people. Of this large investment often not more than 25 or 10 per cent represents structures visible to the eye of the ordinary citizen. To the casual observer water works buildings present the only visible evidence of the excellence of the plant, except the water delivered, and his impression as to the property is likely to be based upon what he can see.

Fundamentally there is no reason why the water works station should not present the same attractive appearance as the City Hall or any other municipal building. It should be permanent, clean, and as easily kept clean as a modern hospital, for it handles a commodity used in every home. An ornate design justified in a City Hall or a Courthouse would be out of place in a pumping station. Rather it should represent the masculine in architecture without undue pretention, strong and permanent in its lines and materials, frankly adapted to its purpose, and presenting an appearance agreeable to the eye. This will require compliance with laws of good architecture. Appearance must not be neglected in structures likely to live a long time.

Permanence

Water works construction is now sufficiently standardized so that it is possible to lay out pumping plants subject to enlargement in such manner that the buildings may be useful indefinitely. The pumping and power equipment should be arranged with the idea of expansion. It

is usually practicable to build only for a moderate time in the future, but it costs little to lay down the indefinite future additions on paper, and so to locate the building, and so to arrange the equipment that extensions may be made without destroying the usefulness of important parts of the plant. It is all too common to find layouts that have expanded piecemeal according to the path of least expense, which must be torn out and rebuilt, because further expansion is impracticable. We can see farther into the future today than was possible a generation ago. There may be radical improvements in water works equipment hereafter, but if the general plan of expansion has sufficient elasticity, the probable future can be accommodated.

In the ordinary water works plant, steam operated, there is, first, the heart of the plant, so to speak, consisting of the main entrance, offices, and possibly a laboratory which may be grouped, and will need little further expansion. The engine room and the boiler room after providing for the present and the immediate future may be expanded along parallel lines without necessarily spoiling the architectural symmetry. It is wise to be liberal in selecting dimensions. This tends toward permanency.

If the water is filtered, it is desirable in small pumping stations to centralize the "business end" of all the station operations on account of facility in supervision. This complicates the design, especially the provision for future expansion, and centralization is not always possible when filtration is added to an old water works. In the layout of a new plant, however, it is practicable so to co-ordinate the expansion of pump room, boiler room, filter plant, coagulation basin, and clear well, that each may be enlarged in an orderly manner with convenience of access between the operating parts and the administrative center of the group. Basins and reservoirs may expand, if necessary, forward from the building, utilizing a space covered over by lawn. Plants in cities up to 100,000 population, or somewhat more, may thus be designed without the necessity for separating the pumping and filtration plants. A compact arrangement is quite necessary for economical operation in a small city where it may be desirable to operate filters without adding to the number of employes.

Fireproof Construction

The modern water works station is fireproof throughout for obvious reasons. Permanency requires it. It should be the last building to burn in any community. Many water works stations are practically fireproof except for the roof construction, windows and the doors. It is practicable to build stations today without using a stick of wood, and at moderate costs as compared to wood. Millwork has increased in price to such extent that there is little difference between wood and metal frames, and concrete and tile construction is generally used for roofs in the most modern stations.

Building Materials

For underground structures or for other structures, more or less concealed and protected from the weather, concrete gives excellent service. Where exposed to view or subjected to the action of the elements, it is not proving a satisfactory building material. Wherever possible it is wise so to design reservoirs that they may be filled over and sodded, thus protecting the concrete from the expansion and contraction of hot sun and winter cold, and incidentally better protecting the water from extremes of temperature.

For superstructures, brick and stone are the most satisfactory materials for exteriors; terra cotta may be useful upon the interior or exterior. Upon the interior the surface should be clean and non-absorbent. Concrete floors are satisfactory only in the cheaper structures where they may be successfully used if covered with a heavy non-absorbent paint especially adapted to concrete. In the better stations terrazzo or tile is justified.

Walls, particularly where damp, as in the pumping pits, should be faced with a non-absorbent substance such as enamel brick built at least head high. Above this plane pressed brick is satisfactory. At present a rock plaster is available almost as hard as stone which can be worked into very attractive panel designs at moderate cost.

For the roof, exposed steel trusses are generally used with steel purlins and a roof covering of reinforced concrete or tile. In order to prevent sweating in cold weather a double ceiling is desirable. This may be accomplished by rock plaster on metal lath hung from the purlins. Thin concrete roofs usually become a nuisance at certain times from dripping. A single thickness of 5 ins. is usually sufficient to prevent the serious collection of drops. A double ceiling completely eliminates the trouble and costs

comparatively little more. Skylights and ventilators must be guarded with gutters for satisfactory results.

It is proposed to cite a few examples of recent pumping station construction with figures of cost. Practically all of this work has been done in co-operation with Mr. Victor A. Matteson, architect, Chicago.

Des Moines Pumping Station

The new 21st street pumping station at Des Moines is a steam station. It pumps the entire water supply of the city in one operation from the ground water collecting galleries into the pipe system against direct pressure. The rates of pumpage at the present time are as follows:

Minimum night rate M. G. D.	6.5
Average Day M. G. D.	10.0
Momentary peak	18.0
Maximum fire demand	24.0

The pumping plant consists of three DeLaval turbo-centrifugal geared units, two of 15, and one 25 million gallons capacity. These pumps operate at 269 ft. total head with 200 lbs. boiler pressure and 100 deg. of superheat. The two smaller of these pumps developed duties on test ranging from 150 to 114 million foot pounds per 1,000 lbs. of steam at full capacity and half capacity respectively. The larger pump is guaranteed to deliver 161 mil. duty at full capacity, 164 at three-fourths capacity and 144 at one-half capacity.

Boiler Plant: The boiler plant consists of four 323 H. P. Springfield water tube boilers. One boiler is served by a La-Clede-Christy natural draft chain grate stoker. Three boilers are equipped with Harrington chain grate stokers operating on natural draft up to 125 percent rating, and forced draft up to 200 percent rating. The plant burns a low grade of bituminous screenings (Poke County, Iowa), ranging from 8,000 to 10,000 B. T. U. The individual boilers and stokers in this plant developed on test from 72 to 74 percent efficiency when operating on natural draft slightly above boiler rating, and 70 percent on forced draft at slightly under 200 percent rating.

This boiler and pumping plant serves the city on about half the tonnage of fuel per unit of water pumped required by the old pumping station, served by hand-fired tubular boilers and compound crank and flywheel pumps. The greater part of the saving is secured by the improved boiler plant.

Coal Handling: The matter of handling coal is a difficult one in a water works boiler plant by reason of the magnitude of the peak load as compared to the comparatively small average load. Coal handling equipment of the type adapted to electric lighting practice often fails to show economy when applied to the small tonnage burned by water works, on account of fixed charges. The device adopted at Des Moines consists of a gantry crane feeding from cars or coal pocket to an overhead bin in the boiler room. It also picks up ashes dumped to the ash pocket by hand, loading the same into cars or trucks. By the use of this crane one man unloads all cars not dumped, and handles all coal and all ashes for a 24 hour shift in three hours or less. The coal handling scheme at Des Moines at the present price of labor a little more than "breaks even" with hand coal handling labor, fixed charges considered. Its installation was considered warranted in view of the probable future increased cost of labor.

Building Group: The group of buildings comprising the new water works pumping station at Des Moines consists of the main pumping station and boiler room, a shop and garage building for the accommodation of all automobiles and trucks used by the Water Department, a warehouse, with pipe yard adjoining, for storing pipe, fittings and miscellaneous supplies; also a group of cottages housing four families of water works employes.

The main pumping station consists of a pump room containing space for eighty million gallons in pumping capacity. Fifty-five million gallons capacity is at present installed. The boiler room contains 1,300 H. P. in boilers and space is provided for enlargement that may be required after 1940.

Adjoining the main entrance to the pumping station are located an office for the chief engineer, a laboratory, and toilet accommodations for the public. Employes' toilet rooms are located between the pump room and boiler room. Galleries are provided in the pump room for the accommodation of visitors, so that the pump room may be seen without interfering with the operation of machinery.

All foundations are constructed of heavy reinforced concrete. The pumps are set 13 ft. below the high water line, thus necessitating a heavy pump pit floor and walls to resist upward and inward pressure. The pumps are thus located

in order to draw from the gallery system in extreme low water.

The pump room is finished with terrazzo floors and white enamel brick walls up to the top of the wainscot at grade line. Above this point the walls are paneled and coated with rock plaster. The roof is supported by steel trusses carrying Federal cement tile with a composition roof covering. Steel windows, doors and trim are used throughout.

The boiler room is finished with concrete floors, with walls of common brick painted. The entry way and halls are floored with terrazzo, and provided with terra cotta walls. The exterior of the building is of dark red tapestry brick with Bedford stone trim.

The shops and garage building exterior finish is similar to pump house. The interior is finished with concrete floors and common brick walls, and the whole is surmounted by a timber mill construction roof, slow burning type, and covered with composition roofing. Steel window sash are used. The remaining millwork is of wood. This building provides all facilities for the maintenance of the water works motive power and contains a wood shop, machine shop, paint shop and in the rear a stable for the accommodation of one team.

The warehouse building resembles a small freight house in general plan with an office space in the front where all water works labor is handled and assigned to its daily tasks. A siding runs parallel with the warehouse with platforms on both sides, so that freight unloaded may be wheeled through the storeroom and loaded on wagons or trucks. Heavy freight such as pipe and large fittings may be unloaded from the opposite side of the cars and stored in the pipe yard. This building is surmounted by a mill construction wood roof. Floors are of concrete and the office walls are plastered. Wood millwork is used throughout this building.

Three wood and stucco English cottages provide for four families. One cottage contains five rooms, one cottage six, and one double cottage contains two six-room apartments. Each apartment is provided with concrete cellar, furnace heat, plumbing, maple floors, plastered exteriors and shingle roofs. These apartments are rented to employes at cost. The rent charged is $30 per month per apartment exclusive of heating and light.

Orlando Water Works and Light Plant

At Orlando, Fla., the new station is now nearing completion. This accommodates the water filtration plant of four million gallons capacity, electrically driven centrifugal pumps of 12 million capacity augmented by four million of steam pumping capacity in another station. The generator room contains 4,000 K. W. in turbo-generators with space for 2,500 additional K. W. The boiler room contains 1,500 H. P. in boilers, oil fired.

The Spanish type of architecture was used, as especially adapted to a warm climate. The boiler room is open on the rear, the boiler fronts being protected by open archways. The walls are of brick with exterior cement plaster. Roofs are supported on steel trusses with concrete slabs and composition surface. Red tile is used for sloping roofs and wall caps. The interior of the pump room is plastered. All other wall surfaces are of common brick painted. Floors are of red quarry tile.

Table I shows the cost of the Orlando building, including filter house and concrete filter beds; also clear water reservoir underneath the filters, but does not include cost of filter equipment or any other equipment of the plant except as stated in the tabulation.

Manistique Tower

The opportunity was afforded at Manistique, Mich., to combine a small electric driven pumping station and a water tower. The water supply at Manistique is delivered by gravity, substantially at ground height, to the center of the town, where it is pumped electrically into a steel elevated tank surmounting the pump house.

The land occupied by the pumping station was donated by a public spirited citizen upon condition that an attractive station and tower should be built. Manistique is a small city with a population about 7,000. A plan was worked out which accommodated the necessary electrically driven pumps in the base of the tower, and the saving thus effected permitted enclosing the tower in an attractive envelope. The cost of the structure thus built is approximately equivalent to an uncovered steel elevated tank plus a separate building of fireproof construction.

The steel tank contains 200,000 gallons. The top is located 107 ft. above the ground. It has a hemispherical bottom and is supported on the brick work 64 ft. above ground by means of eight short legs horizontally braced. The tower is constructed of brick with red tapestry

face brick. The trimming on the lower portion of the tower is Bedford stone and the cornice is constructed of reinforced concrete cast in place. The dome is of zinc supported on wood trusses.

The tower is octagonal outside and 16-sided inside. The brick cross-section is sufficient to support the superimposed load with a unit pressure not exceeding 175 lbs. per square inch.

The 16-sided pump room is 33 ft. in inscribed diameter. It is floored with terrazzo with white enamel brick wainscot, and rock plaster walls and ceiling. A false roof is provided over the pump room with drains to catch any drip or leakage from the elevated tank. A cellar under the pump room accommodates all pipes, heating and plumbing equipment.

The electric pumps are pressure controlled from the tank and start and stop automatically. No attendant is required in the operation of the plant except for periodical visits for inspection and oiling.

Gary Station and Water Tower

The Gary pumping station and water tower, although built a number of years ago, is an example of what is possible in the use of concrete.

The water tower is simply a housing for a steel elevated tank supported on vertical steel legs entirely independent from the envelope. This plan was followed on account of the necessity for haste in providing a water supply for the city during the building period. The concrete envelope was added later. The shaft of the tower is of reinforced concrete with a concrete dome roof. The base of all cornices and the facing on the lower one-fifth of the tower is of precast concrete applied in the usual manner where stone is used. The shaft proper is of reinforced concrete with a reinforced concrete dome roof.

The pumping station has concrete foundations. The pump room is depressed below the ground level and is lined with white enamel brick. Above grade walls are of brick with buff pressed brick interior face, and precast concrete exterior face. The exterior face blocks are of two colors, gray and dull red.

Ashland, Ky.

The Ashland, Ky., plant exemplifies construction for a small city. It includes an electric driven pumping station with gasoline reserve pump; also a water filtration plant. Construction throughout is entirely fireproof and of good appearance, but no extra money was spent for the sake of appearance.

The entrance to the plant is through the operating floor of the filtration plant. The filter beds produce a terrace effect.

Upon the Ohio river the intake problem is important on account of the extreme variation between high water and low water. The low lift pumps are located in a pit 26 ft. in diameter and 43 ft. deep. They consist of two motor driven centrifugals and one high speed gas engine centrifugal, each 2½ M. G. D. against 65 ft. head. Three pumps of the same kind of capacity operate against 275 ft. head when pumping to the city. These pumps and the filters are installed on the roof of the clear well.

The filtration plant consists of four beds, total capacity 2 2-3 M. G. D. High velocity of wash is used from a 35,000-gal. steel wash tank set on the roof of the pump pit.

Ironwood, Mich.

This plant develops a ground water supply from driven wells and pumps it against a head of 650 ft. through a four-mile pipe line of 16 ins. diameter. The water is developed from three shallow well groups, each sub-station containing a 2 M. G. D. pump. The main pumping station contains two three million gallon electric driven centrifugals and one and one-half million gallon high speed gas engine driven centrifugal. One gasoline driven centrifugal is also installed for reserve low lift pumping.

The buildings connected with the Ironwood water works are all constructed from boulders picked up on the water works lot. The saving thus effected as compared to brick was nominal, but it is believed that these buildings present better appearance than would brick structures in the locality where built.

The main pump house has walls of boulder stone plastered inside on metal lath and painted, floors of concrete painted, and the roof is slate on wood with matched and beaded ceiling oiled, and exposing steel trusses. Three similar sub-pumping stations were built and as the plant is located some distance from habitation, it was necessary to construct two six-room dwellings also built of boulder stone.

Prairie Du Chien, Wis.

This plant represents the practicabilities in a small town where the funds available for water works construction were quite limited. This pumping plant consists of a concrete pit 45 ft. inside diameter by 24 ft. deep surmounted by a mill construction wooden roof with a

small brick building attached to the pit at the ground level for office and shop purposes.

This plant is electrically operated. Water is sucked directly from four driven wells immediately outside the pit wall and discharged into the pipe system which is connected to an elevated reservoir on the adjoining bluffs. The pumping installation consists of one motor driven centrifugal 500 G. M., 340 ft. head, one 600 G. M. high speed gasoline engine centrifugal, and one 600 G. M. motor driven triplex pump moved from an old pumping station. Space is provided for a fourth pump at some time in the future.

All foundations are of reinforced concrete. The superstructure and the parapet around pumping pit is common brick with moderate priced face brick. All sills, lintels and caps are built of precast concrete. All roofs are of wood construction. The composition roof covering of the pit is concealed by the brick. The roof of the office and shop structure is finished with cement interlocking tile. Concrete floors are used throughout. Interior walls of brick are painted.

Cost of Pumping Stations

The cost of the pumping stations that have been described and several others are shown in Table I. As the prices of labor and material have fluctuated quite materially during the period in which these stations were built there is shown in the table the date of the contract, the price basis at the time and the price basis at the present time. The table also shows the cubic foot cost of the stations as of the time when let and as of the present time. In computing cubic foot cost the contents of the building have been figured based on outside measurements and taking the height from the footing level to the average outside surface of the roof for each part of the building.

The tabulated price basis is the average cost of building materials as published by the U. S. Department of Labor. This refers to the average prices of 1913 as 100 per cent. The use of this price base presupposes a fluctuation in labor equal to the fluctuation in material price. The price of labor generally fluctuates less than the price of material. However, it is true that the efficiency of labor enters into contract cost and it is generally true that when materials are high labor is scarce and its efficiency decreases, therefore tending to make labor cost more nearly fluctuate with the prices of materials. Apparently the assumption made regarding labor does not seriously affect the comparisons of cost, for the unit prices appear to line up very well in the comparison of buildings.

Comparison of Costs

In comparing the costs of buildings there are innumerable factors that might be considered. Pumping stations, however, are generally similar in type and vary principally in dimensions and in the degree of finish. In theory the cost of roofs and floors varies directly as to area and that the cost of walls increases 43 per cent in doubling the area or decreases 14 per cent when the area is cut in half. These proportions hold only for perfect equares, but the difference is small for an ordinary rectangular building. Miscellaneous details such as plumbing and

TABLE I—COST OF PUMPING STATION BUILDINGS

	Cost	Contract Date	Cu. ft. —(Thousands)	Cost per cu. ft.	*Cost Price Base	*Present Price Base (Mar., 1923)	**Present Cost per cu. ft.
PUMPING STATIONS—							
Des Moines, Iowa	$220,479	1920-23	810	27.0c	178	198	30.0c
Ashland, Ky.	34,194	Oct., 1921	130	26.4	159	198	32.8
Orlando, Fla.	91,800	Sept., 1922	510	18.0	180	198	19.8
Ironwood, Mich.							
Main Station	29,155	July, 1920	65	44.8	269	198	33.0
Sub Stations	9,644	July, 1920	7.5	64.2	269	198	47.6
Manistique, Mich.	71,379	Sept., 1921	140	51.0	156	198	65.0
LaCrosse, Wis.	50,834	Nov., 1912	484	10.5	100	198	20.8
Prairie du Chien, Wis.	21,017	Sept., 1921	77.8	27.0	156	198	34.3
AUXILIARY BUILDINGS—							
Des Moines Garage	51,027	May, 1922	390	13.1	160	198	16.2
Des Moines Warehouse	18,754	May, 1922	111	16.8	160	198	21.0
Des Moines Cottages							
3 Cottages, 4 Fam. 22 Rooms	20,430	May, 1922	18	29.2	160	198	36.0
Ironwood Cottages							
2 Cottages, 2 Fam. 12 Rooms	16,900	July, 1920	16	44.5	269	198	33.0

* Building materials U. S. Dept. of Labor.
— Each building where more than one—Contents based on outside measurements footing to average roof.
** As of Date April 1, 1923.

heating are considered to vary directly with cubic contents.

Upon the above basis the cost per cubic foot of an ordinary pumping station is decreased about 14 per cent in doubling its contents and it is increased about 13 per cent when its contents are cut in half.

It has been noted that the cost of box type reinforced concrete reservoirs follows closely the cost of moderate priced buildings.

Architectural Co-operation

It would be well if all engineers would utilize the services of an architect in the planning of conspicuous engineering works. A good architect possesses a knowledge of orderly arrangement, and the selection and grouping of materials, not possessed by most engineers. On many classes of structure the architect should be and is the master builder, and the engineer is properly a subordinate. Upon such special structures as water works buildings, the engineer must be the master builder, but he is wise if he fully utilizes the services of one skilled in architectural design. This must be done by co-operation; the engineering plans should be worked out together, step by step, as a unit.

The water works manager should not ignore public approval relating to his work and his plant. Self-respect engenders respect from others. Capable operators say that employes take better care of their machinery and are more contented when working in attractive surroundings. A good plant is an important element of good service. The time has come when water works designers can safely plan for the future and build for permanence.

The foregoing is from a paper presented by Mr. Burdick at the recent annual meeting of the American Water Works Association.

PROGRESS IN MUNICIPAL PLAYGROUND AND RECREATION ACTIVITIES

By Mabel Travis Wood, Playground and Recreation Association of America, 315 Fourth Ave., New York, N. Y.

Last year cities in the United States gave more money and thought to public play than ever before, as is shown by the Year Book statistics of the Playground and Recreation Association of America. The 1922 expenditures for playground and recreation purposes listed by 472 of the 505 cities sending reports complete enough for publication totalled $9,317,048.79, an increase of nearly half a million dollars over the amount reported in 1921.

A few years ago a city considered itself progressive if it gave its children a summer playground. Now 215 cities make the provision of supervised recreation for young and old their year-round job, and consider their play facilities as important an asset as good roads and proper sanitation. A comparison of 1921 and 1922 reports shows that during the later year 90 more recreation centers were maintained under paid leadership the year round, 169 cities reporting a total of 895 such centers. There was also a substantial increase in the number of summer centers, 2,624 being reported by 417 in 1921 and 2,834 by 416 cities in 1922.

From its beginning the recreation movement has emphasized the importance of securing trained leadership. Experience has proven that one playground under direction is worth more than two where children play at random. Particularly encouraging, then, is a 30 per cent gain during 1922 in the number of trained play directors employed the year round. This number reached 2,026, while the total number of paid workers, including those employed on part time, was 10,867. Many cities are conducting classes to train workers in play direction. Forty-seven cities reported an enrollment of 2,143 students in training classes for paid workers, and of 70 cities having classes for training volunteer workers, 39 reported an enrollment of 1,440.

There has been an increase in facilities as well as in leadership. New swimming pools, tennis courts, athletic fields and municipal summer camps have played their part in the 1922 recreation progress. Thirty-five cities reported gifts of playground sites by public-spirited citizens. The value of only 15 of these was announced, but this amounted to $611,400. One hundred and eighty cities now report swimming pools, as contrasted with 122 in 1921. The following figures show how cities are making up to the modern youngster—and his parents, too—the delights of the "old swimmin' hole" of yesteryear.

	Cities Reporting.	Total.
Swimming pools	180	465
Public baths	101	398
Bathing beaches	127	223

Two hundred and eighty-six community buildings used exclusively for rec-

reation purposes are now maintained by 111 cities. Fifty-two cities stated the value of their community buildings, the total being $8,595,548.

In districts where cities have not yet been able to supply playgrounds, they are safeguarding street play by closing streets at stated hours and providing play leaders. That street play receives more attention each year is proven by these Year Book statistics:

	1922	1921	1920
Cities reporting streets closed for play	53	38	29
Cities reporting streets closed for play under leadership	36	25	17
Cities reporting streets closed for coasting	131	98	96

One of the outstanding values of playground work during 1922 has been its effect upon juvenile delinquency. Not only does money spent for wholesome recreation lower expenditures for juvenile courts and reformatories, but it builds constructive citizenship. In St. Louis, a decrease of 75 per cent in the number of juvenile court cases was reported in a single district after the establishment of a playground. Since the Recreation Commission of Passaic, New Jersey, opened a recreation hall where 68 basket-ball teams have their games, the juvenile judge is seriously considering closing his court. The boys are so busy at play that they have no time to get into mischief. In Yakima, Washington, juvenile delinquency was reduced 50 per cent after the establishment of a recreation program by a local Community Service committee. Through an athletic club a gang of boys well known to the court became a force for better citizenship, putting up street signs, organizing a night school and working with the judge to help other boys go straight.

The sources of support of the recreation work in the 505 cities reporting to the Year Book were listed as follows:

Municipal funds	238
Private funds	140
Municipal and private funds	118
County funds	7
State, municipal and private funds	2

During 1922 18 cities, including Oxnard, California, Kansas City, Kansas, Holyoke, Massachusetts, Roselle, New Jersey, Winston-Salem, North Carolina, and Scranton, Pennsylvania, voted bond issues for recreation purposes to the total of $1,155,180.

Statistics on the number of people who daily enjoyed public play activities last year prove that money spent for this purpose was very economically administered. A dollar spent for recreation seems to go at least as far as a dollar spent for any other civic purpose. Commenting upon the economy of supervised recreation and urging wider play expenditures for 1923, the Playground and Recreation Association of America points out that the United States spends for tobacco, candy, chewing gum, soft drinks and theater admissions over $9,400,000 daily, which is more than the expenditure for public recreation by 472 cities during the entire year of 1922. The per capita cost for these luxuries is $32, while the per capita cost for public recreation, a recognized necessity, is 9 cts.

REPORT OF COMMITTEE ON SALARIES OF ENGINEERS IN PUBLIC SERVICE

(Editor's Note—Following is the full text of the report of the Committee on Salaries of Engineers in Public Service of the American Association of Engineers as presented at the recent annual convention of the Association at Norfolk, Va. The editor of this magazine, who was Chairman of the Committee, wrote the report. Constructive criticism of the report is invited.)

The Committee on Salaries of Engineers in Public Service has been trying to work out a program of activities which, if carried on over a period of years, will increase the salaries of these engineers and improve their working conditions.

The committee submitted a progress report to the Board of Directors at its meeting on Sept. 29-30, 1922, which was approved and commended by the Board. The progress report was further elaborated in an article published on pages 9 and 10 of "Professional Engineer" for December, 1922. This article, outlining a program of suggested activities, has been the basis of correspondence between the chairman and the active members of the committee. The present report is the net of these studies to date. The tentative conclusions of the committee are presented herewith with comment on each item in the recommended program.

1. The members all agree that the Association should re-affirm its faith in the fairness and efficacy of the salary schedules it has already adopted. These schedules are based on a classification of engineering positions of varying responsibility. It is possible that this classification could be improved and varied to

suit local and general living costs, but it is felt that if we could place all public engineering offices on these schedules, the condition of engineers would be much improved. So far as possible it is desirable, also, to standardize the titles and duties of engineers in public service.

2. Copies of these schedules should be placed, as recommendations, in the hands of all local authorities who have a voice in fixing the compensation of engineers. The cost of this would be negligible in comparison with the benefits. Random distribution would be of much less value than distribution timed to reach a particular locality so as to synchronize with the efforts of the local engineers in their own behalf.

3. The tenure of office, in general, is short and insecure and this affects both the public and the engineer adversely. Engineers should seek the co-operation of other employes in impressing upon the public the wisdom of establishing a permanent staff in every governmental organization, showing the increase of efficiency with experience, and the value of a staff familiar with problems that carry forward from one political administration to another.

4. Sentiment in the committee is divided as to the wisdom of placing engineers in public service under civil service regulations; some are strongly in favor of the proposal and some are strongly opposed. All agree that the subject is worthy of further detailed study and specific recommendation.

5. Local publicity given to the best work of the engineer brings him to the favorable attention of his public and enhances his opportunity to secure adequate compensation.

6. Statutes and ordinances that fix salaries can be, and frequently are, amended. Engineers should seek advances openly through amendment, just as they would go about amending existing statues and ordinances for any other purpose. If they want increased compensation they must work for it, and apply their energies at the point where relief can be secured. Where possible the Association should assist in local compensation matters and chapters and clubs should feel that some bureau, committee or individual is ready to respond when a local opportunity arises to adjust compensation.

7. Engineers in public service should favor the employment of as few men as are able to do the work properly. When it is necessary to economize, because of decrease in work or for other reasons, it is much better to lay off unnecessary employes and possibly increase the duties of the remaining employes, rather than to keep them all at reduced compensation.

8. All chief engineers should be alert in the interests of their subordinates, advancing their salaries if and when they can. This will react in favor of the chief as he is bound to benefit from an improved rating of engineers. In large organizations of technical employes, department associations and a close relationship of all members from chief to rodman are recommended.

9. The Association should continue to favor the state licensing of engineers so as to place professional engineering on a higher plan, to gain recognition from the general public and public officials, to keep the profession free from incompetents and unworthy practitioners, and to safeguard public safety, health and welfare.

10. The committee is not in full agreement as to the wisdom and propriety, on theoretical grounds, of the engineer carrying one or more sidelines, whether commercial or professional. The majority oppose this practice, as an academic proposition, but concede that with salaries as they are at present the public service engineer must sometimes do outside work in order to make ends meet. Sidelines have undoubtedly made it possible for many engineers to remain in the public service and until such time as salaries are adequate the Association should not discourage the man who seeks an income in addition to his regular salary, provided always that he can do so without slighting his regular occupation. There is small danger of excessive development in this direction as municipal administrations are, as a rule, jealous of the employes' time and it is seldom feasible, in practice, to develop a sideline to excess.

11. The desire for formal advertising of the money-saving value of good engineering, and of the nature of the service rendered the public by the professional engineer, is growing rapidly. This is a matter of primary importance to all engineers including, of course, engineers in public service.

Reference is here made, not to publicity stories and news items, but to paid advertising in some popular magazine of very large circulation.

One member of the committee has stated the case for advertising so well that his observations are quoted herewith: "The man in the other professions renders his service to his client direct; his efforts are known and appreciated by the ultimate consumer, the public. The services of the engineer largely combine with the services of others and with raw material into a finished product which becomes the object of barter and in which product the brain service of the engineer is lost to view. How then shall the public be made to appreciate the service rendered by the trained engineer? The answer is by advertising. Not the kind of advertising we associate with a new breakfast food or a brand of soap, but dignified advertising emphasizing the value of trained engineering service, the service that results not only in added safety and convenience to the public, but also in economic savings." Another member of the committee says there is "a gross ignorance, not so much of the responsibilities the engineer carries, but of the difference in results possible from good engineering as compared to no engineering, or poor engineering. In other words, the public is inclined to think that engineering is standardized and that a given piece of construction designed and carried out by this engineer, or that engineer, will produce the same result at the same cost."

Since millions of the most influential people can be reached through a single medium and be thereby made familiar with the essential nature of the engineer's work and with its great economic value to the public, it seems an easy decision to reach that the Association should set about the formulating and financing of such an advertising program. The effect of such an enterprise on the morale of the whole profession, as well as on the members of the Association, would be electric. It would dwarf anything ever undertaken by engineers in the service of the profession and the public.

In conclusion it is well to point out that just as long as engineers will work for their present small salaries the public is not going to worry at all about what the engineer thinks of the inadequacy of these salaries. The engineer need not delude himself that his sacrifices are appreciated by anybody but his family and himself, for they are not. The attitude of the public is, in the first instance, one of supreme indifference as to the engineer's compensation. This will always be true as the public is made up of individuals who are hustling for a livelihood in one way or another, and who haven't time to worry about any underpaid professional class. When, in the second instance, the public learns of the engineer's discontent these questions immediately are raised: "He knew what the job paid before he asked for it. If he didn't like the pay why did he ask for the job? If the pay is so poor why do so many seek these jobs?" The engineer's eternal hope for an increase, based on recognition of the true value of his services, as well as his more or less unselfish desire to render a public service, alike are unknown to the desperately busy and preoccupied public.

Intensive local activities, sincere cooperation between all the grades of the profession, all projected against a background of national publicity on the true nature and value of professional engineering, as herein suggested, will bring the results the engineer so long has sought.

THE AIRPLANE PHOTOGRAPH AN AID TO CITY PLANNING

City planners, commercial clubs and any number of private business enterprises are calling upon the aerial camera men for photographic maps, in verticals and bird's-eye-view obliques, says Charles Phelps Cushing, writing in Colliers, The National Weekly, for June 16, 1923. Mr. Cushing's article continues:

Kansas City, Mo.

In Kansas City, Mo., an airplane camera man on orders from a city planning commission, has been shooting a set of verticals that cover a territory of 60 square miles—the entire area of the city west of the Kaw River.

Day after day for three weeks he soared over the business section and suburbs, at a height of 7,200 ft. about the hilltops, and through a hole cut in the bottom of his plane snapped 670 plates. When the prints taken from these were trimmed and fitted together they made up a photograph of Kansas City half as big as the side of a box car. There, 600 ft. to an inch, was a detailed picture of this city where 325,000 people dwell, a picture complete to every house and tree and even antlike motor cars crawling along the streets.

Today the city planning commissioners

meet and draw up their chairs before a photograph almost as large as the wall of the room in which they gather to confer. "Where should ground be cleared downtown for the new civic center?" A committeeman who has an idea in answer to that question can arise and place his finger upon the exact spot. He can argue from an accurate, up-to-date, actual photograph of the conditions there, and no one present can fail to understand precisely what he is talking about. "Where is a new East Side boulevard connection needed?" Right here, perhaps. Or, "Where does the swift residental growth of the South Side now demand another small park for a recreation spot?" Visual evidence, facts disclosed by the photograph, answer such questions best. The commissioners not only can consult that air map as their aid in present need; they also have for their files a historical record of priceless worth to the future. A costly portrait, true. The photographer's bill ran to upward of $8,000—but money ungrudged because it was spent in a good cause, that of making Kansas City a better and better place to live in.

Newark, N. J.

Another municipality which has successfully used the air snap-shot, an eastern city which western towns often pay the compliment of claiming it shows kinship to the western spirit, is Newark, N. J. There the aerial camera man's customer was the Department of Streets and Public Improvements. One of this board's particular problems was to decide where to cut through a traffic connection downtown to relieve street congestion near a market place. The air map, one of the committeemen reported later, helped to solve a puzzle which no amount of statistics on traffic, or detailed reports from the building commissioner, or blue prints from the surveyor's office, could have cleared up so easily and quickly.

The list of American cities that have been photographed both in oblique and vertical is short. Add the downtown section of Hartford, Conn., and Manhattan Island (the business borough of New York City) and you complete it. The mapping of Manhattan Island was not commissioned by an official order; but officials have, none the less, found it of value for reference. Health officers and fire department officials have pored over these prints studying housing conditions; and traffic cops have found the actual photographs of the volume and the distribution of traffic in Fifth Avenue and Broadway a source of valuable information.

Surburban New York

The environs of New York, photographed in high obliques from elevations of 8,000 to 15,000 ft., have been taken on the order of a commission which is studying surburban planning and transit-line developments. In these high-flying bird's eyes the lay of the land is shown with much unnecessary detail eliminated. In these, visualized so that the whole situation can be taken in at a glance, are shown the towns, residental developments, transit lines and highways, congested spots and waste lands; and a prophetic eye can mark indications of the direction of future growth.

Though the airplane photograph is not yet widely used in this country by public officials, it already is well recognized as a new aid in city planning. We are far behind France, at present, in making it of public service; in France, since the war, more than 300 towns and cities have been mapped, including Paris, whose airplane portrait in verticals was made at a cost of 2,000,000 francs.

Semi-official use of airplane snapshots in the United States——if you class commercial clubs as semi-official—has been more extensive. A score or more of these clubs have made effective use of obliques for city advertising and booklet publicity.

But the greatest use of the aerial photograph in our country today is by private business enterprise. In this field we far outstrip the French.

One of the first of such commercial uses in publicity was by a constructor of big office buildings in New York City, who printed air snapshots of business sections of Manhattan Island to show at a glance what a large proportion of the city's famous skyscrapers have been erected by his firm.

One of the largest New York hotels early found that an airplane snapshot was the only sort of view that could do real justice to the hotel's size and situation, and show vividly the advantages of the location for handiness to the shopping district, the theaters, and the railway terminals.

Similar views are now being used by a glass manufacturer to furnish visual evidence of the vast amount of glass that a big city buys; and by a cement products association, which contends (and

with justice) that the public does not half understand how varied and extensive are the modern uses of cement.

Doubtless you have noticed, too, in recent advertising, that many factories are seizing upon the aerial bird's eye to show their customers what the trade describes as the plant behind the product.

Such close-ups from above—the camera man calls them character studies—are gaining great popularity with city real estate men, for they visualize to the customer in a flash the location of buildings and transit lines, industrial sites, both actual and potential, transit lines and switch tracks, highways, and even the amount of traffic in the streets.

To the promoter of surburban residential developments the airplane snap-shot is equally useful. It shows the streets, the parks, and boulevards, the amount of construction, in process and completed, and the character of it all, the foliage, the street car lines, the location of schools and churches and shops, and the entire lay of the land, to every hole and hazard of the golf links. A suburban real estate man in Kansas City, who was one of the first to have his properties photographed from the air, makes this further observation on the worth of the idea:

"You learn a lot from it yourself, too. You see not only what you have, but for what you need to plan. If he has vision, a real estate man can discover a city from the air. With an airplane view to help him visualize the situation he can glimpse a city of the future and plan for ten years or twenty or a generation ahead."

REDUCING RAILROAD - HIGHWAY CROSSING ACCIDENTS.

By H. A. Rowe, Claims Attorney, Delaware, Lackawanna and Western Railroad Co., 90 West Street, New York, N. Y.

The American Railway Association has determined upon a renewal this year of the activities of its Safety Section for the prevention or reduction of railroad-highway crossing accidents and its plans will shortly be in effect.

During the past 25 years there has grown up within our country an industry almost unparalleled for the rapidity and extent of its development. From practically a zero point in 1898, the automotive industry has advanced to a production of 2,576,000 autos and trucks in the year just past. On Dec. 31, 1922, there were actually registered within continental United States 12,357,376 automobiles, or the equivalent of one auto to every 8.7 persons throughout the country and the end is not yet.

In 1898, there were 657 deaths at railroad highway crossings and in 1917, the peak was attained when 1,969 deaths occurred at such crossings. Injuries have grown from 1,123 in 1898, to 5,383 in 1922.

The Interstate Commerce Commission in its report for 1922, states there were 1,810 persons killed and 5,383 injured in 1922, at such crossings.

During the five years ending Dec. 31, 1921, there were 9,101 persons killed and 24,208 injured at railroad highway crossings. These figures are sufficient to indicate the serious increase of such deaths and injuries and to impress upon us the need for action toward their curtailment.

The necessity for their prevention or reduction appeals to us from several angles.

Humanity

First. That of humanity. Who of us can escape the pangs of regret when we read or hear of those who have been unnecessarily sacrificed in such mishaps, or can escape the sympathetic touching of our heartstrings when we dwell upon the thought of the pain, the suffering, and the mutilation borne by those who may survive, but pay a substantial penalty for someone's carelessness. For humanity's sake alone, all well disposed men should lend their very best efforts to a diminution of the risk, if such diminution can be pointed out.

Public Duty

Second. That of public duty. As citizens, cognizant of our duties to each other, it behooves us to demand competency and care from auto drivers equal to that which we demand from engine drivers. Any lessening of this standard is a winking at the incapable and reckless auto driver.

Pride

Third. That of pride. Consider the injury to the pride of these highminded, capable railroad executives whose ambition it is to not only conduct their roads efficiently but with a deep satisfaction in the safety of travelers upon their railroads. It can not be said that railroad executives are unmindful of the injury and death to travelers over the high-

way, but it can be freely admitted that their solicitation for the safety of the passengers upon their trains is a paramount care, and because of the frequency of train derailments arising from highway crossing accidents, an additional alarm is felt.

Cost

Fourth. That of cost. I did not mention this first, because I know from experience that railroad executives are actuated by a higher motive than the avoidance of the payment of money, notwithstanding the fact that practically all crossing accidents in certain states are simply an assessment of damage by juries.

There are several ways to grapple the problem of highway crossing accident prevention: (1) by engineering; (2) by education; (3) by legal process.

Let us consider them:

By Engineering

On the 31st day of December, 1921, there were 252,022 grade level crossings over class 1 railroads operating within the United States, after deducting 485 crossings which were eliminated that year.

The elimination of the crossing by separation of grades is the absolute solution of the problem. In considering it, however, we are instantly confronted with two elements which are insurmountable.

The element of Time. Aa the rate which crossings have been eliminated in the last five years, it will take about 600 years to remove them and though the matter of elimination be speeded tremendously, yet we are safe in saying that generations of time are involved in their ultimate removal.

It is proper that crossings in densely congested areas be first selected for elimination, but the futility of expecting much from such elimination arises when we recognize that most of our crossing accidents occur in rural communities, frequently where the view of the traveler upon the highway is most excellent.

The element of Cost. The question of cost makes elimination by separation of grades prohibitive. Competent engineers say that taking the crossings of our country by and large, a reasonable estimate of the cost of removal in rural and urban districts would approximate not less than $50,000 per crossing. (Upon the road I have the honor to represent, an estimate of $50,000 for the removal of a certain crossing was made before the war. We are not engaged upon the work of that removal and its cost this year will be nearer to $125,000.)

Simple arithmetic then tells us that the cost of elimination by separation of grades is in excess of $12,500,000,000, practically all of which would be non-revenue producing and impossible of obtainment.

Enginering, however, embraces other details than elimination, such for instance, as the establishment of highways parallel to the railroad instead of permitting the crossing and recrossing of the track by the same highway. In this manner many crossings can be eliminated with a minimum of expense. Island turnouts are in use upon some highways requiring the driver to deliberately turn at a right angle and then to the left, thus affording opportunity for observation from both angles before passing over a railroad track. This is suited to specific situations only.

Engineering also includes the removal of unnecessary obstructions to view; the maintenance of present crossings in good order for travel; the construction and operation of mechanical barriers, such as standard, flexible and rigid crossing gates, and various forms of visual and audible signals including automatic flagmen.

Railroads should not cease their study and adoption of warning devices until perfection is reached and should bear particularly in mind the increasing development of enclosed cars making audible signals of lesser value than formerly. In the winter season, with the windows of an enclosed car up, safety is dependent almost exclusively upon the single sense of sight.

We may also include under the general heading of engineering the proper equipment of motive power with efficient and legal whistle, bell and headlight. The installation of these means of warning are of no avail, however, unless employes are properly trained in their use and carefully watched, checked and disciplined for every deviation from effective warning.

Crossing watchmen must be selected for their physical and mental qualifications, and harsh though it may seem, the halt, maimed, decrepit and mentally unqualified crossing flagman must be removed and replaced with competent successors, or automatic devices.

By Education

It is believed that in the education of the auto driver to the exercise of the highest degree of care and the insistent demand on the part of his passengers, whether paid passengers or guests, that he no longer gamble with their lives but appreciate fully his moral and legal responsibility for those in the car with him, we have put our finger upon the spot where the immediate remedy rests and it is to education that the Committee on Prevention of Highway Crossing Accidents, Safety Section, American Railway Association is addressing its efforts.

Many are familiar with the campaign which the American Railway Association conducted last year by posterizing almost every community in our country; securing the support of the President of the United States; of national, state and civic officers and organizations, the press, and the motion picture industry of our country.

This was the beginning of our task, and while the results in figures did not prove that a single effort could be made and mishaps stopped, yet there was substantial encouragement that we are on the right track, even though the end of the road be far beyond our horizon.

During the four months of the 1922 campaign 758 persons were killed at highway crossings, compared with 685 in 1921, an increase of 73. However, 61 of the 73 occurred in the month of June, before the campaign was making itself felt. There was an increase of only 12 in the last three months of the campaign. This indicates unmistakably that the public is amenable to direction towards its own safety.

This year we shall tackle this problem with new vigor, having developed a poster vastly superior to our original, profiting in this, and in other respects, by the experience gained. We have sacrificed all reference to a campaign, to any period of time, and to the American Railway Association, in the firm belief that with these things omitted, the public will more readily grasp the situation as being its problem and realize that it must pull its own chestnuts out of the fire. It is believed that approximately two millions of these posters will be distributed throughout our country. There will be a replica of the poster as a windshield sticker upon automobiles. Last year we used a correspondence sticker for railroad mail, and it will be continued this year.

A new feature is the use of a postal card inviting membership into a Careful Crossing Club. Undoubtedly a substantial use will be made of this feature. The co-operation of the moving picture industry has again been proffered, both in the use of slides which are duplicates of this year's poster, and of a secondary poster which will be used for variation, as well as the display of a series of pictures showing preventable accidents.

Arrangements have been made for the teaching of safety at crossings by means of the motion picture in standard films and without referring to the purpose which is being accomplished. A series of bulletin boards have been arranged for, to be placed away from railroad tracks and bearing a replica of the poster very much enlarged. Electrotypes and matrices of the poster will be freely used by local newspapers. The Automobile Blue Book will carry our slogan as a caution at railroad intersections and arrangements have been made with the road-map publishers emphasizing the need of care at crossings.

Suggested Resolution

Influential organizations have been requested formally to pass the following resolution:

WHEREAS, it is recognized that the number of automobiles using our public highways is constantly increasing and has created hazards of travel beyond those of former years, and indications point to an increased growth in the use of such highways. And

WHEREAS, Our public highways traverse and cross the tracks of steam railroads throughout the country at grade level, there being over a quarter of a million railroad-highway crossings, and because of the enormous expense and generations of time involved in the ultimate removal of such railroad-highway crossings. And

WHEREAS, The number of serious and fatal injuries arising out of accidents at such railroad-highway crossings is becoming a matter of public concern. Therefore be it

RESOLVED: That the.....
.....place itself on record as approving the efforts of the American Railway Association to encourage travelers upon the highway,

particularly those using automobiles, to exercise a high degree of care at railroad-highway intersections, and this body urges upon its membership wholehearted personal co-operation in discouraging reckless disregard of danger at such crossings.

Safety Regulations at Railroad Grade Crossings

Inasmuch as our highways are in such common use today, serious effort should be made to enact and enforce as nearly as possible uniform highway traffic laws. Simplicity should be the dominant feature of such laws to afford a fuller understanding. It must be recognized that the present use of the highway presents entirely different aspects from the period when most of our laws were established and that progress must be accepted by and demanded from the state, the railroads and the users of the highway.

It should be the duty of state, county and local officials to construct highways *parallel* to railroad tracks where there is a frequent crossing and recrossing of the same highway within a limited area.

The highway approach to railroad crossings should be established within a moderate maximum grade and be maintained in excellent order.

The construction or development of barriers to view, at or near railroad crossings should be prohibited.

It should be obligatory on the part of the road authorities to compel the removal of unnecessary barriers to view, adjacent to a railroad crossing.

There should be established at uniform distances a standard sign along the highway indicating the approach to a railroad crossing.

It should be forbidden to mutilate, alter or change a railroad crossing sign or approach sign, or to simulate or represent any such sign for commercial purposes.

Commercial advertising of every character should be absolutely forbidden between the advance sign along the highway and the railroad track.

There should be a standard and uniform sign solely to indicate a railroad crossing and wherever possible one post should contain all indications at crossings for simplification.

At every crossing where the view is restricted by immovable barriers there should be an automatic warning device.

Wherever practical, railroads should seriously consider the substitution of automatic warning devices in place of manual protection. Automatic devices are on duty 24 hours of the day, are less affected by failures, and offer positive opportunity of proof that warning was given.

Serious attention should be paid to the suggestion that all highways crossing railroad tracks at grade, whether protected or otherwise, should be plainly marked with three distinctive lateral lines indicating that tracks are 200 ft., 100 ft. and 25 ft. distant, respectively.

Licensing officers should exercise increasing care in granting licenses only to those physically and mentally qualified. Minimum eye and ear standards should be established. A certificate of a responsible opthalmologist and aurist should accompany application for license.

Authorities having the power to issue licenses to drivers should be empowered and required to revoke such licenses and deny renewal for substantial period in cases of driving while intoxicated, recklessness, incompetency or defiance of local regulations or frequency of mishaps.

State licensing authorities should be empowered to require a report from a driver covering every automobile accident within the state. Failure to report within ten days should automatically revoke license. Repeated collisions with crossing gates or subjecting flagmen to unnecessary hazards should be sufficient cause for revocation.

Driving while under the influence of liquor or drugs or grossly reckless driving should be a criminal offense and subject to jail sentence instead of fine.

It should be illegal to drive a car over a railroad track at a higher rate of speed than ten miles per hour, and there should be established a sufficient police force in every community to make this rule effective.

Require state, county or municipal authorities to provide police traffic regulation at all railroad crossings traversed by more than 250 vehicles within 24 hour period.

Require automobiles carrying freight or passengers for hire to come to a full stop between 25 and 75 ft. from railroad crossings and not to proceed until the way is known to be clear. This can be made effective by rewards upon conviction.

Automobiles should be required to have ample braking power and the braking devices and equipment should be periodically inspected and reported to the licensing officer. There should be substantial

punishment for both driven and owner of automobile in mishaps due to brake failures.

Require prosecuting attorneys to endeavor to enforce the statutes against manslaughter as against drivers of cars responsible for the death of passengers in automobiles or trains.

It should be made impossible for the owner of a vehicle to protect himself by insurance for the first $100 loss or damage in public liability cases. The reliance upon an insurance carrier to pay minor damages tends to indifference and lack of care.

These suggestions are simply skimming the surface of our needs and are not intended to be the result of exhaustive study. They are offered for what they are worth in the sincere hope that something of value may be contained therein to assist in checking the human and economic wastage at crossings and at the same time make the way clearer and safer for those who properly should enjoy the pleasures afforded by our modern means of transportation. We wage no war upon the automobile (most of us are interested as owners). On the contrary, we are exerting ourselves to free it from the stigma of a slaughtering agency when operated by the criminally reckless or heedless. There is an excellent opportunity before all public authorities charged with the construction, maintenance and control of traffic on highways and those interested in the operation of vehicles over our highways, to co-operate practically and sincerely in the laudable effort to check the increase of railroad-highway crossing accidents and there will be abundant gratification for all in the saving of human suffering and no one will be loser by his co-operation.

The foregoing is a report by Mr. Rowe to the recent annual meeting of the National Highway Traffic Association.

PROFITABLE SALE OF EXHAUST STEAM FOR MUNICIPAL HEATING AT MILES CITY, MONT.

A few years ago Miles City, Montana, erected a new city hall and fire station within a block of its water and electric station. It was decided that instead of installing an individual boiler in the new building they would install some underground heating pipes and heat the building by means of the exhaust steam from the electric station. Accordingly about 600 ft. of underground piping was installed and the building was satisfactorily heated without the use of live steam and with no perceptible back pressure.

The first adventure being successful, and the business men desiring the service, it was decided a year later to serve the business section of the city with heat. Accordingly plans and specifications were drawn for the underground piping system and contracts were let. With materials on the ground the city was stopped from proceeding with the work by an injunction secured by one of the property owners who claimed that the city was without authority to enter into a general heating business. It was argued in the courts and decisions rendered by the Supreme Court of the state that the city had a right to enter any business that an individual could, providing such business did not become a burden upon others than those directly benefited. It was later shown in court that the city was losing more than $100 per day by not selling the exhaust steam from the electric station and the jury decided that the city should proceed with its plan.

Development of System

Installation of approximately 1,800 ft. of underground mains was completed during 1912, and in 1917 about 1,600 ft. more were added. At the end of the year 1917, the underground system consisted of 3,953 ft. of mains varying in size from 14 ins. to 6 ins. and 2,154 ft. of services ranging from 4 ins. to 2 ins. Forty-seven buildings containing 4,656,300 cu. ft. of space and 65,139 sq. ft. of radiation were heated. The original cost of the distribution system was $42,508.

At no time during the history of this plant has exhaust steam been considered without a value to the electric department. Many cities have considered exhaust steam a waste and without value, allowing the heating department the use of such steam without paying the electric department for the steam.

Operating Figures

Quoting from the report of the superintendent, J. J. McGill, for the year ending Dec. 31, 1917:

Investment in heating department	$42,508.10
Gross Revenue	16,708.00
Labor and maintenance	561.60
Exhaust steam at 25c per 1,000 lbs., 37,691,000 lbs. (33,137,000 lbs. sold)	9,422.50

Depreciation, 5 percent	2,125.40
Total Expense	$12,109.50
Net Income	4,598.50
or 10.8 percent on investment	
Credit to electric department	9,422.50
Total Earnings to City	$14,021.00
or 33 percent on investment	

That same year the public service commission's report showed an earning of 34.5 per cent on the heating investment. This was due to the fact that the public service commission made no charge for exhaust steam, considering it a by-product without value. This basis is erroneous, for the back-pressure on engines does slightly reduce the efficiency of engines and causes an increase in operation directly chargeable to the heating department.

The utilities of Miles City maintained their old rates in face of advances of operating cost as long as they could without detriment to service and operating results. But like all utilities they found it necessary to increase rates during 1920, and accordingly petitioned the public service commission for increases. Such increases were granted and went into effect Nov. 1, 1920.

The rates in force as of Jan. 1, 1920, were as follows:

Heating

Condensation Per Month	Rate Per 1,000 Lbs.
1st 10,000 lbs.	$0.90
Next 10,000 lbs.	.76
Next 10,000 lbs.	.73
Next 10,000 lbs.	.69
Next 10,000 lbs.	.62
All over 50,000 lbs.	.55

Minimum bill $5 per month.
Discount, 20 percent if paid before 25th

Electric Rate—Lighting

Current Used Per Month	Rate Per K. W.
1st 50 K. W.	$0.10
Next 50 K. W.	.09
Next 200 K. W.	.08
Next 200 K. W.	.07
Next 500 K. W.	.06
All over 1,000 K. W.	.04

Minimum bill, $1 net.
Discount, 10 percent if paid before 25th

Power Rate

Current Used Per Month	Rate Per K. W.
1st 100 K. W.	$0.05
Next 100 K. W.	.04½
Next 200 K. W.	.04
Next 200 K. W.	.03½
Next 200 K. W.	.03
Next 200 K. W.	.02
All over 1,000 K. W.	.01½

Special rate of 1c per K. W. for pumping city water.
This charge is made in order to separate the water and electric departments.
Minimum Rate on 1 H. P. or less, $1.50 per month.
Minimum Rate on 2 H. P. or over, $1 per month.

Country Lighting on 6600-Volt Line

Current Used Per Month	Rate Per K. W.
1st 10 K. W.	$0.12
Next 40 K. W.	.10
Next 50 K. W.	.09
Next 200 K. W.	.08
Next 200 K. W.	.07
All over 500 K. W.	.06

Minimum bill per month, $1.50 net.
Discount, 10 percent if paid before 25th.
These rates were increased as of Nov. 1, 1920, as follows:

Heating

Condensation Per Month	Rate Per 1,000 Lbs.
1st 10,000 lbs.	$1.20
Next 10,000 lbs.	1.10
Next 10,000 lbs.	.90
Next 20,000 lbs.	.80
Over 50,000 lbs.	.70

Minimum bill, $5 per month net.
Rate based on $4 per ton Montana coal delivered at plant.

Whenever the cost of coal so delivered is more or less than $4 per ton, an addition or reduction, as the case may be, will be made to the rate of 2c per 1,000 lbs. condensation for every 10c or major fraction thereof in the cost of coal.

Electric Rates—Lighting

Current Used Per Month	Rate Per K. W.
1st 50 K. W.	$0.12
Next 50 K. W.	.11
Next 200 K. W.	.10
Next 200 K. W.	.09
Next 500 K. W.	.07
Over 1,000 K. W.	.05

Minimum, $1.10 net.
Discount, 5 percent if paid before the 25th.

Power

Motors of 1 H. P. or less, $1.25 per month and motors over 1 H. P. per month per H. P. connected plus following rate:

	Rate Per K. W.
1 H. P. or less	$0.04
2 H. P. or less	.0375
3 H. P. or less	.035
5 H. P. or less	.0325
7½ H. P. or less	.03
10 H. P. or less	.0275
15 H. P. or less	.025
20 H. P. or less	.0225
25 H. P. or less	.02
35 H. P. or less	.0175
50 H. P. or less	.015
75 H. P. and over	.0125

Country Lighting

Current Used Per Month	Rate Per K. W.
1st 10 K. W.	$0.15
Next 40 K. W.	.13
Next 50 K. W.	.11
Next 200 K. W.	.09
Next 200 K. W.	.08
All over 500 K. W.	.07

Minimum, $1.50 net.
Discount, 5% if paid before 25th.

Note: The slight increase in electric rate during war prices. This is due to the credit to lighting department from heating department.

Operation of Heating Department for 1920

The operation of the heating department for the year 1920, which includes two months at the new rate is given as follows by Mr. McGill:

Investment—		
Mains, services and meters		$52,000.00
Revenue—		
Heat sales, 55,065,000 lbs.		32,449.87
Fuel for entire plant (electric and heating depts.)	$77,738.44	
Boiler room labor	19,856.00	
		97,594.44
25% of fuel and boiler room labor charged to heating department	$24,398.61	

*This item is characterized as too high by J. J. McGill, superintendent of the Light and Power Department.

General salaries and expenses (25% of total charged to heating dept.)	2,232.38*	
Maintenance of meters, customers' inspection and reading meters	991.19	
Replacement reserve	2,080.00	
Earnings	2,747.69	
		$32,449.87

Earnings on investment, 5.3%.
Earnings on investment including credit to electric department of $26,630.99, 58%.

If the present rate had been in force during the entire year the revenue would have been $38,691.69, or $6,241.82 increase, which would have produced an earning of $8,989.51, or 17.3% on investment, not considering the credit to the electric department. Note that overall earnings of heating department have increased from 33% to 58% in 1920.

It is interesting to note that Mr. McGill changed for 1920 his method allocation of station expense from that used in 1917. Formerly all steam was charged to the heating department at 25c per 1,000 lbs. The heating department is now charged with 25% of the entire fuel and labor of boiler room. This means an increase to the heating department of 57% over 1917, while the new rate to customers is but 40% increase over 1917.

Further analysis of the operation of this plant shows that if all steam were charged to the two departments on a live steam basis the heating department would be charged with 30%, instead of 25%, of the fuel and boiler room expense. Thus, when it is considered that practically all of the steam furnished the heating department was exhaust, it is believed that 25% is a fair basis for Miles City. However, with the increasing of the electric load and the heating load remaining about the same, the time will come when 25% will be unfair to the heating department.

Mr. McGill reports that in eight years his heating load increased until he heated 98% of the business adjacent to his underground system. He had many applications from outlying districts for service but realized that the revenue from such districts would not pay the interest on the investment and advised his council against such extensions.

There is no question but that our coal supply can be greatly conserved if other municipalities will adopt the same methods as are now being used at Miles City. It must be kept in mind that the fuel committees of this country and Canada laid great stress upon conserving our fuel supplies. The Canadian committee recommended central station heating plants, where greater boiler efficiency would be secured and the same amount of heating be accomplished with less coal.

HOW INDIVIDUAL ORGANIZATIONS CAN FIT THEIR WORK INTO A BROAD HIGHWAY RESEARCH PROGRAM

By Dr. W. K. Hatt, Director Advisory Board on Highway Research, National Research Council, Washington, D. C.

Immediate Work of Research

In order to determine what each can do to expedite the collection of authentic data on the basis of which highways may be wisely selected to meet the economic needs of the region, properly built to conform to the economics of the situation, and operated in the interest of the public, the immediate necessities may be outlined:

(1) Many problems in highway engineering are accompanied by corollary problems in economics of highway transport. For instance: What sum may profitably be spent in capital costs of construction to reduce a grade? The answer must depend on volume of traffic and on operating costs of road and vehicle. Again, decisions upon changing second-class into paved roads involve cost of road maintenance, tires, gasoline, and repairs and depreciation to vehicles, etc. The reduction of operating costs due to improved surfaces are large on roads of heavy traffic; how heavy? The reflex action of improved alignment on change of design of vehicle also suggests itself. Reliable data appear to be largely wanting. Research activities should be pushed.

(2) The study of methods of financing road construction, and the distribution of the expense between those benefited, awaits fact-finding surveys. The study itself needs the services of trained economists. The sources from which the tax dollar comes, and its distribution among roads, education, charities, etc., should probably be determined.

(3) Studies of the effect of highway improvements on land values are needed; and also of the effect of highway improvements upon industry and the development of typical regions, such as

truck farming or resort areas. The results of such studies will be a guide for similar areas under development.

(4) The laws governing the growth and dispersion of traffic, and the mechanics and psychology of safely handling such traffic in congested areas, need study by research methods.

(5) The purpose and methods of, and the instrumental equipment for, basic traffic surveys upon which state construction and maintenance funds may be allocated is a live issue. A simple instrument for automatically counting and weighing traffic is now under development in the Bureau of Public Roads.

(6) The large volume of valuable data, accumulated at the cost of hundreds of thousands of dollars, through studies of soil properties, effect of loads and strength of slab—data that underlie the as yet undisclosed principles of the mechanics of slab design, should be brought together and analyzed to uncover the principles of action. The instrumental equipment and technique in this field represent a remarkable advance in the science of measurement. With the mechanical principles determined, then the engineer can be given formulas for fitting the road to the load. If these principles are still hidden, final coordinated researches should be planned to settle these questions. If it is true, as it seems to be, that stiff slabs on soft subgrades should be thick at the edges and thinner at the center, what should be the proper distribution of the thickness, and how should slabs be reinforced to provide longitudinal stiffness?

(7) The economics of pavement types in specified situations must be learned from carefully gathered data, so that decisions may be made less upon ex-parte arguments and more upon exact information.

(8) The findings of laboratory tests upon materials of construction should be scrutinized in the light of experience in operation to determine to what extent these tests are predictive of service value in the road. Studies of the destructive action of alkali and sea water upon concrete structures are of interest to highway engineers.

The above problems are pressing for early solution. Research is not only of direct daily use, but is insurance.

It is not too much to say that there must be created a new realm of economic data to quiet opinionated discussion of moot questions in the field of highway transport. How can issues be settled or college courses in highway transport be established except on the basis of scientific information, gained from surveys of existing traffic and collection of data of costs of operation of road and vehicle, maintenance data, study of taxation and benefits? The end may be reached by,

(a) Evaluating the present information.

(b) Planning new researches where needed.

(c) Publishing authentic data as fast as they are accumulated.

Grouping of Organizations

During the development of highways in the past years, various voluntary organizations have arisen to meet needs and influence policies. The existing list of organizations discloses cases of duplication of effort and indefiniteness of purpose.

More recently organizations have entered the field with some official status and legislative duties, and possibilities of expansion to greater power, such as the American Association of State Highway Officials.

The following list of consistent members of the Advisory Board on Highway Research of the National Research Council represents the several fields of highway activity: American Association of State Highway Officials; American Concrete Institute; American Institute of Consulting Engineers; American Society of Civil Engineers; American Society of Mechanical Engineers; American Road Builders' Association; American Society for Municipal Improvements; American Society for Testing Materials; Associated General Contractors of America; Association of American State Geologists; Association of Land Grant Colleges; Bureau of Public Roads, U. S. Department of Agriculture; Bureau of Standards, U. S. Department of Commerce; Corps of Engineers, U. S. Army; Engineering Foundation; Eno Foundation; National Automobile Chamber of Commerce; National Highway Traffic Association; National Safety Council; Rubber Association of America; Society of Automotive Engineers; Western Society of Engineers.

If representation were had from steam railway and electric traction interests, as far as these are related to highways, the circle would be complete.

It is a difficult task to select a group of organizations signally prepared to carry on specific researches. However, the following list includes organizations operating in well defined fields, and which, taken together, fill the needs of highway research to a fairly satisfactory degree:

A. Production of Research Data

1. Research program and coordination: Advisory Board on Highway Research.

2. Mechanics and psychology of traffic signs and codes: Eno Foundation.

3. Vehicle design and operation: Society of Automotive Engineers, and Bureau of Standards.

4. Structural Design of Roads: Bureau of Public Roads, State Highway Commissions, and Universities.

5. Maintenance studies: State Highway Commissions, and Bureau of Public Roads.

6. Character and use of materials: Bureau of Public Roads, State Highway Commissions, Bureau of Standards, Universities, Industrial laboratories, and State geologists.

7. Basic traffic surveys: State Highway Commissions.

8. Highway transport studies: Bureau of Public Roads, State Highway Commissions, and Universities.

9. Economics of location, road resistance, and power requirements as affected by alignment and surface, and of operation factors: Bureau of Public Roads, State Highway Commissions, Universities, Society of Automotive Engineers, Bureau of Standards, and U. S. Army.

10. Construction plants: American Road Builders' Association, Associated General Contractors, State Highway Commissions, and American Society of Mechanical Engineers.

B. Collection of Statistics

1. Cost of transport: (a) Road: Bureau of Public Roads. (b) Vehicle: Society of Automotive Engineers, National Automobile Chamber of Commerce, and Associated General Contractors.

2. Theory of finance: Departments of Economics of Universities, Bureau of Public Roads, and State Highway Commissions.

C. Standards of Regulation and Recommended Practice

1. Methods of testing materials: American Society for Testing Materials, Association of State Highway Officials, Bureau of Standards, and Bureau of Public Roads.

2. Structures: Bureau of Public Roads, Association of State Highway Officials, and American Society of Civil Engineers.

3. Standard plans for roads and records: Bureau of Public Roads, Association of State Highway Officials, and American Road Builders' Association.

4. Use of road: Association of State Highway Officials, National Highway Traffic Association, and National Automobile Chamber of Commerce.

5. Signs and signals: Eno Foundation, American Standards Committee, Association of State Highway Officials, National Highway Traffic Association, and National Safety Council.

D. Coordination of Transportation Agencies

Bureau of Public Roads, U. S. Chamber of Commerce, National Automobile Chamber of Commerce, Interstate Commerce Commission, and Department of Commerce.

E. Education in Colleges and Common Schools

Highway Education Board, and Association of Land Grant Colleges.

A glance at the above lists of subject matter and agencies will indicate that the Bureau of Public Roads and the state highway commissions and universities are the three active agencies in the production of research data. Through the Advisory Board on Highway Research these three agencies are closely in touch with each other's work and pursue a unified purpose.

The most useful service of the Bureau of Public Roads is in fundamentals, in the discovery of broad principles and general properties, and in the development of the technique of highway research applicable to the entire country. The universities can cooperate in the research problems of the state highway commissions because their special equipment and expert staff are prepared for such service, and because they are zealous in industrial development of the states. The state highway commissions are much better prepared than are the universities for the routine business of reception tests of materials.

In the fields of vehicle design and op-

eration the chief agencies must be the Society of Automotive Engineers and the Bureau of Standards. It is increasingly evident that the highway engineer and the automotive engineer must work more closely together.

Of the 27 agencies listed, some are not directly operating in the production of research data. They deal with policies, with education, or with standards, the foundation of which, however, must be the research data. These agencies follow the general psychology of the human being, viz. an instinct for action, even the absence of information necessary for wise judgments. Indeed, in the pressing necessity for roads to discharge existing traffic, it is not to be hoped that research will ever catch up with construction and use. Indeed the need for research is only seen when use develops problems. However, we must remember that our program of highway construction is not near its peak activity, and the use of research in saving construction and operating cost has yet a wide field for application.

Function of Advisory Board on Highway Research

The large number of organizations for highway research shows real need of such an agency as the Advisory Board, first of all to determine the status of several fields of research to determine if each has been sufficiently occupied, then to plan and stimulate researches in fields that need occupying, and to coordinate the programs.

For example, during the past year a conference was called by the Advisory Board and attended by the various researches who are measuring the resistance of the road to the translation of vehicles, in order that some definition might be reached of the purpose of such experiments, and of the limits of the fields of work of the highway engineer and the automotive engineer. In this conference it appeared that the object of these experiments was to determine the rolling and air resistance to the passage of vehicles over highways of various alignments and surfaces. It also appeared that the existing data of road resistance was sufficient for the purpose.

The automotive engineer in turn should determine by laboratory tests the power characteristics of the vehicle, and the fuel, oil and grease consumption, from which the performance of the vehicle can be calculated on various surfaces and grades, and the excess power for trailers determined to a substantial accuracy.

The other operating costs of repairs, depreciation, etc., can best be determined by statistics of average costs collected for types of vehicles in regions containing homogeneous classes of roads.

Upon the assembled data the locating engineer can adjust capital expenditure to operating costs for a predicted traffic.

A suggested layout of work is as follows:

A. Research for Automotive Engineer

1. By laboratory tests to determine:

(a) Fuel, oil and grease consumption and power development of vehicle and from these to calculate the performance on various surfaces and grades, and the excess power for moving trailers. See Bulletin of Michigan State Highway Department on Experiments, by Prof. W. E. Lay.

(b) To study the effect of improved grades on the design of the power plant of the vehicle.

(c) To consider the design of the vehicle in order to impose on the road the minimum loads for specified capacity of vehicle.

(d) To study the lighting system of autos with a view to safety, and the mechanisms indicating intentions of the driver.

B. Research for Highway Engineers

1. To find rolling and air resistance of motor vehicles at various loadings and speeds on types of road surfaces and curves; limit of adhesion.

2. To determine the loads imposed on road surfaces by various vehicles, with various tire equipment at various speeds.

3. To measure the stresses and strains acting in various road surfacings under the expected loads, and the properties and improvement of subsoils, and the character and use of materials of construction.

4. To determine capital and maintenance costs resident in the road.

5. To determine the laws governing the increase of highway traffic by basic surveys of flow of traffic in typical regions.

C. Research for N. A. C. C. and Auto Associations

1. To assign schedule cards to a selected group of, say, 200 passenger drivers for each condition, to obtain operating expenses on the average for:

(a) Three classes of cars;

(b) Regional conditions: Macadam and gravel roads, Dirt roads, Paved roads.

(c) Topography: Level, and Hilly.

2. To study records of truck and pas-

senger bus fleets to obtain similar data.

D. Locating Highway Engineer

Given road resistance, power available at wheels, speeds, fuel, oil, and grease consumption, tires, repairs, driver's time, depreciation, overhead, expected traffic,

To find: Relation between capital costs of construction and operating expenses on roads of various surface and grades (length and rate).

E. Federal Agencies

1. To study movements of commodities and passengers by highway and railway in the interest of coordination of transport.

2. To study the financing of highway improvements in the light of experience and science in related fields of financing of public improvements.

3. To study the effect of highway improvements on regional industries.

4. To study the effect of highway improvements upon general productivity of men and industries.

F. Advisory Board on Highway Research

To evaluate progress in the several fields of highway research by an analysis of completed and current projects; to outline needed researches; and to assist existing organizations to correlate their work in the light of a comprehensive program; and to publish bulletins of information on methods and technique of research, and on progress in the several fields.

Through the Committee on Structural Design of the Advisory Board a conference was held of those responsible for the three major researches upon structural design of roads, at Pittsburg, California, the Bates road in Illinois, and the Bureau of Public Roads experimental work at Arlington, Virginia. At this conference the content of these researches and the apparent indications were discussed and suggestions for useful extension of the program accepted by those in charge.

Bulletin No. 21 of the National Research Council entitled "Highway Research Projects in the United States," gave the results of a survey of the various research projects now under way throughout the United States. The projects were divided both geographically and as to subject matter, and each one described in such a way that the reader might know the purpose and nature of the experiment. Such a survey serves two purposes: First, to put individual researchers into communication with each other so that the methods and instruments might be comparable; and second, so that one state might be saved the expense of seeking an answer to questions that had already been answered in the neighboring state. An additional service of the bulletin will be the indication of fruitful fields of research to those agencies who have the will to work and the means of accomplishment.

The Field of Highway Research

A broad consideration of highway research would lead to a twofold division; first, a study of materials going into the roads and the design of sections to the end that they may be mechanically fit to withstand the forces coming upon them from climate and traffic; and second, the economic data of costs of transportation, not only to permit a wise location of roads to fit the economic needs of the region, but also to serve to educate the public whose judgment must finally determine the progress of highway construction. For instance, the data obtained at the Iowa State College of the relative operating cost of traffic over dirt roads and paved roads, and the experiments at the University of Michigan, clearly show the savings to the people of the state through the paving of roads.

Nor must we narrow the field of research to the purely engineering factors of the highway problem. Theories of finance resulting from experience in other fields of public undertakings will be applicable to problems of highway finance. Commodity surveys, to determine just what use is being made of the highways, are necessary for wise judgments upon the relation of the building of highways to the transportation needs of the nation. It is these broad fields of public policy that are particularly important just now in respect to the prosecution of research.

Activity in constructing and in testing constructions runs far ahead of analysis. The gross or surface appearance of experiments is not always reliable, and it is only after the careful analysis of data of deformations from various standpoints that the underlying truths appear. A proportion of the money now spent in research could profitably be devoted to the financing of a corps of analysts who would scrutinize the marshalled data and determine the issues involved. Such an organization of analysis should be provided either for the Advisory Board on

Highway Research, or for the United States Bureau of Public Roads.

Another need is for a publication for the findings of research after the work of the analysts has been completed and the committees have met. Many valuable data and reports lie buried in the files of the state highway commissions, the industrial organizations, federal departments and universities.

I can think of no more useful service to be performed by the organization connected with highway construction than contributions to some agency for the purpose of the analysis and publication of the large volume of data now available. The subject seems important enough from the national standpoint, because the cost of highway transportation is estimated at 7 to 8 billion dollars a year, which is one-tenth of the national income. It would justify the support by some of the many foundation funds now devoted to the study of various economic and scientific problems. It is of course difficult to interest such bodies in work of this kind which seems to most persons to be only in engineering and industrial fields, and to lack that human appeal which accompanies a study of public health and the problems of government. Various organizations have live contact with potential sources of support of such an agency. It apparently needs only a group of individuals who will arrange that the work of the Advisory Board on Highway Research will be adequately financed for a period of five years. In this way the acknowledged potentialities for useful service of our committee will be realized and the collection of data and analysis be expedited in the interest of highway development.

The foregoing paper by Dr. Hatt was presented at the recent annual meeting of the American Road Builders' Association.

STANDARD HIGHWAY DANGER SIGNS

(Editor's Note: Following is the full text of the report of the Committee of the National Highway Traffic Association on Highway Danger Signs as presented at the 1923 annual meeting of the Association, by Mr. G. C. Dillman, Deputy State Highway Commissioner of Michigan, chairman of the committee.)

It goes without saying that an important function of our national highway system is the erection of and maintenance of adequate danger signs. Each sign should be placed for some specific purpose and the interpretation of any one sign should be the same throughout the country. To accomplish this, danger signs should be standardized in all states. This is a matter largely educational and it will take considerable persuasion on the part of a number of organizations such as the National Highway Traffic Association to convince the many state agencies that they should adopt a system of danger signs that may mean abandonment of the system now in vogue. There has been a general tendency on the part of all states, that have gone into this matter, to create something along lines entirely different than in the neighboring states. Therefore the report of this committee, in view of the many ideas concerning danger signs, will cover certain recommendations that it is believed worthy of consideration by this Association.

Recommended Standard Practice

(1) Danger signs should be uniform in both shape and lettering or convention.

(2) Lettering and convention should be simple so the observer grasps the meaning without undue mental effort.

(3) Color scheme should be limited to black lettering on a white background.

(4) Frequency of display. These signs should be used only where it is very necessary that they be placed as it is believed that too frequent use of them will depreciate their value as a safety measure to the traveling public. Too frequent and unnecessary use of them will discredit the value of such signs.

(5) Location. It is recommended that (a) the erection of the center of the signs be about 4 feet above the center of the road surface; (b) that the sign be located 1 foot outside the outer shoulder line of the road grade; (c) that the sign be located 500 feet back from the source of danger.

(6) Shape of signs. Danger signs be of four different and distinct shapes indicating the degree and nature of danger as follows:

Round indicating R. R. Crossing.
Octagonal, indicating Stop.
Diamond, indicating Slow.
Square, indicating Caution.

(7) Railroad Crossing Sign. The rail-

road grade crossing sign should be circular in shape and 2 ft. in diameter with a cross on it and the letters "R. R" above the horizontal line, one on either side of the vertical bar. (This particular sign has been officially adopted in a number of states.)

(8) Stop Sign. This shall be octagonal in shape, 2 ft. across, with the word "Stop" printed across the face with letters 9 in. high. Such sign should be used where it is dangerous for traffic to advance further without stopping and it is preferable that such sign be displayed in the center of the roadway.

(9) Slow Sign. Signs indicating slow speed shall be made 2 ft. square in size, displayed with its longest dimensions vertical and horizontal, giving it a diamond shaped appearance. This sign might carry such words as "Slow," "Hill," "Curve," "Loose Gravel," "Fresh Tar," "Narrow Road," "Turn," etc. Lettering should be about 9 in. in height diagonally across the face of the sign.

(10) Caution Sign. These signs shall be 2 ft. square so set that the top and bottom of the sign shall be horizontal with the roadway. It may carry such words as "School," "Cross Road," "Side Road," etc.

The Mississippi Valley Association of State Highway Officials, at their last annual meeting at Chicago adopted a committee report embodying the foregoing principles and during the past few months a number of states have adopted a system of highway danger signs in line with these recommendations.

The above recommendations cover only one conventional sign, namely, that for railroad grade crossings. It is suggested that further consideration and discussion be given the matter of convention for signs to mark curves, cross roads, etc.

The subject of automatic and mechanical danger signals and signs may have a proper place in a system of standardized danger signs, but on account of the great variety of these signals some of which are patented and the cost for general use is prohibitive, and the fact that there is a possibility that certain devices will not operate continuously without attention, thus injecting an occasional interval when the traveling public is not adequately protected, such devices have not been considered a part of the recommended standardized system of highway danger signs.

SECONDARY USES OF FIRE HYDRANTS

By John W. Toyne, Engineer, South Bend, Ind.

It was but the outgrowth of the common use, by every one, of the "town pump" that directed the use of its successor, the public fire hydrant, and made it the general temporary water service medium; and it is not surprising that this use of the fire hydrant became universal, especially in municipally owned water utilities.

So universal is this practice that I have failed to find a single municipally owned plant where secondary hydrant service is not rendered, either voluntarily or otherwise, and very few privately owned plants prevent this objectionable practice.

Within the past month, I was in a small city in northern Indiana, and was informed that no service was permitted from the fire hydrants, yet in less than an hour I saw a building contractor, a crew cleaning sewers, a teamster watering his team in a tub, and a tank wagon filling, all using fire hydrants. In two of the cases, Stillson wrenches were being used to operate the hydrants with the usual results, and I noted where a number of other hydrants had experienced the same treatment.

I have talked with a number of city officials relative to this practice and have been surprised at the lack of thought that has been given the two most essential elements entering into the consideration of this abuse of one of the most necessary pieces of fire fighting equipment—cost and reliability.

Thousands of dollars are appropriated for the purpose of fire fighting apparatus —pumpers, hose wagons, deluge sets, aerials, in fact everything that the ingenuity of man can conceive and contrive that will tend to assist the firemen in their work of fighting fire, and surely the administrators of our municipal government would be subject to severe criticism if they failed in their duty in this respect. At the same time, permission will be granted, to almost any one desiring water for almost any purpose, to use a fire hydrant, notwithstanding the fact that the hydrant is not designed as a service connection and that its use as such, not only builds up an exorbitant maintenance cost but reduces the available fire protection.

This latter statement is not merely

assumption based on the law of averages, but is fact, proven by actual conditions that have come under my observation, and no doubt parallel cases have been within the experience of almost every one connected with water utility of fire protection work. I will cite one or two instances—not that they are unique or novel in any way—but because they are pertinent to the subject under discussion. A fire alarm was answered in an addition where the streets were badly cut up through sewer construction. The hydrant that should have been used was tied up with a service line, without even a union and by the time the hose wagon had backed out to another hydrant, the house had burned down. At a hydrant ordinarily used by the street sprinkler for filling purposes, and on which the side cap was usually left open, a handful of small rock was discharged into the fire hose plugging the nozzle and allowing a roof fire, set to wood shingles from an adjacent fire to gain considerable headway before the hydrant could be closed, the nozzle removed and another substituted. Small boys were severely criticized for dropping the rock into the hydrant, but as I see it the criticism was directed to the wrong place entirely.

It would be difficult to estimate the cost in property damage and loss of life that has accrued from this practice and that is continuing as one of our disgraces.

The foregoing discussion is from a paper by Mr. Toyne before the recent annual meeting of the American Water Works Association.

ADDITIONAL SOURCES OF INCOME FOR SMALL WATER PLANTS

By Howard A. Dill, Richmond City Water Works, Richmond, Ind.

Water companies have the advantage over telephone, gas, electric and railway utilities in regard to competition.

For that reason less effort is generally made by water utilities to advertise their product and secure additional consumers, or to increase the consumption of existing consumers. Because water is a necessity and there is no substitute is no reason why water utilities cannot obtain additional revenue by a well planned campaign of advertising and salesmanship. Any superintendent can cite cases of properties which are supplied with well water, instead of by the water mains in front of such properties. Advertising and personal contact would doubtless convince many persons of the desirability of using city water that is protected by laboratory tests, that can be had by opening a faucet, and that is obtained from an unfailing source of supply, all at a cost of a few cents a day. Baths and toilets would be added in many cases if an effort were made by the utility to show customers the convenience and sanitary advantages of such equipment. Sprinkling use could be increased by educating the consumer to the effect of, and enhanced value from a beautifully kept lawn, or a quantity of shrubbery effectively placed about the house.

Water companies could well afford to make a survey to locate properties using well water, and then sell the advantages of city water to the owners of such properties.

Gas and electric companies have demonstrations and exhibitions of their products, and sell equipment using them.

The advisability and desirability of water companies selling material and fixtures at or near cost to customers is a debatable question. There would be objections, of course, on the part of dealers and plumbers, but such a method would undoubtedly encourage the installation of such fixtures. The plumbers, I believe, would be benefited, as the installations would be made by them. In large cities where city water only is used, a possible increase in revenues would be by such methods as indicated.

Softened Water

In smaller cities, however, and perhaps in some cases in larger cities, residences are supplied from cisterns, collecting rain water from the roofs. This requires the additional equipment of a hand pump or of a pressure or gravity tank and an electric motor and pump. By this means softer water is obtained for bath, washstand, kitchen and laundry use. It is from this class that additional revenue can be secured. Cisterns are expensive to construct if of a size adequately to meet the demand. They give trouble from leakage and require frequent cleaning. The electric motor gets out of order and depreciates, and there is also the item of pipe installation.

The Zeolite method of softening water is not new, and is used by laundries, hotels, apartment houses and steam boilers. No additional revenue would be derived from such consumers, as city water would be used by them with or without a softener.

From residents using cistern water, however, there is a decided possibility of increased receipts. A campaign could be made demonstrating the advantages of Zeolite softened water, over cistern water, such as its greater softness, its cleanliness and its reliability of supply.

In the case of new residences, it can be shown that the cost of a Zeolite softener is little, if any, more than the equipment for cistern water. The operating cost of the former is nominal, the salt used costing from $5 to $10 a year. There is no depreciation, the time necessary in operating is very small, and the method is simple. There are several makes of softeners, resulting in closer competition and reduced cost.

A cistern and filter of 80 barrels capacity and electric motor will cost about $250, as compared with the same amount for a softener to supply a family of four with one bath and laundry.

For a family of six, a cistern of 150 barrels, motor, etc., would cost about $350, a softener $335.

For a family of eight or more, two 150 barrel cisterns, motor, etc., would cost about $585, a softener about $500.

Richmond, Indiana, has a population of about 30,000. The water company is a private one, its supply being secured from springs and infiltration galleries, naturally filtered through gravel strata. The hardness of the water is 20 to 22. Most of the residences occupied by the owners have cisterns, the better class of which use electric or water motors to pump the rain water. Electric motors are gradually superseding the water motor, thus reducing the consumption of city water. Within the past two years, probably 20 new houses have installed Zeolite softeners, several of these through the efforts of the water company.

Advertising is being used, and prospective customers shown the comparative advantages and costs of the Zeolite and cistern equipment. The company does not recommend a particular make of softener, but gives the prospect the names of the manufacturers or agents.

The writer installed a softener in December, 1921. The water used the first year for house use and back-washing the softener amounted to 37,500 gals., and the salt used was 600 lbs. If a cistern had been used, the water company would have lost the revenue from the consumption given above.

This is an instance of one possible source of revenue, and one which we believe is capable of development.

The foregoing paper by Mr. Dill was presented at the recent annual meeting of the American Water Works Association.

HIGHWAY TRANSPORT CLEARING HOUSES

By Tom Snyder, Sec. Indiana Transfer and Warehousemen's Association, Indianapolis, Indiana

(Editor's Note: Following is the progress report of the Committee of the National Highway Traffic Association on "Highway Transport Clearing Houses," of which Mr. Snyder is chairman.)

To individualize, standardize, and to stabilize motor transport as a definite force in American industry, requires that motor transport clearing houses be established in all shipping centers, and that the function of these clearing houses be as democratic as the highway itself.

The development of motor transport service is not keeping pace with the demand, nor is the collection of dependable data, covering experience in operating, keeping pace with the growing demand for regulation.

During the past four months twenty-one state legislative bodies considered the question of motor transport regulation, but all of these groups were wholly without such information as would be necessary in forming the first foundation stone for such regulation.

A highway transport house would first centralize the demand and supply for motor transportation, it would be confronted immediately with the problem of freight collection for a certain portion of the demand, and it would be compelled to find the most adequate method of store door, or platform delivery, of commodities transportable.

A clearing house would be required to quote rates for service. These rates would be for store door, platform, or ferry delivery, and in store door delivery would vary with truck load or less than truck load consignments.

To quote constructive rates would require the analysis of cost of operation upon the ton mile basis for various distances, upon various kinds of highways, under conditions peculiar to the season, and with various truck units.

After a very general survey extending from coast to coast, we are thoroughly convinced that the major portion of all motor transport adventures have been

financial failures, due, tc a large extent, to the lack of such knowledge as motor transport clearing houses would find it necessary to obtain, as their first function of activity.

Railway terminal congestion and resulting transportation delays have again reached the point of industrial obstruction, and many shippers in every American city are seeking relief in motor transportation. To whom will the shipper appeal for such relief? He may be referred to the Jones Trucking Company, which operates a line to Batesville, also to the Smith Transport Company, which operates irregularly over several other routes, and so on, but he is sure to find a lack of uniformity in methods of operation, in rates, in schedules, and in service responsibility.

The shipper fears to subject his consignees to these questionable conditions, and the benefits of an improved service are lost to all concerned, because the clearing house is not there to connect up supply and demand.

Furniture warehousemen in America are rapidly accepting the theory that a furniture warehouse is the clearing house between homes and that the transportation of household goods either from home to warehouse or from warehouse to home for any reasonable distance is one of the normal functions of the warehouse company.

This accepted point of view is rapidly bringing about a dependable, connected transportation service in moving household goods for constantly increasing distances, and by constantly improving uniform methods providing also for that most important return load.

The commercial warehousemen of America are rapidly recognizing the commercial warehouse as the motor transport clearing house between warehouse supply and the distributor or retailer. These developments of this idea will bring about a great change in the method and cost of distributing society's daily need, and a constantly increasing volume of L. C. L. short haul commodities will move directly from warehouse to the retailer, instead of passing through the shipping department of the jobber or wholesaler.

That class of jobbers and wholesalers whose business consists chiefly of L. C. L. short haul commodities, such as wholesale grocers, druggists, dry goods, hardware, etc., are the greatest sufferers from inadequate transportation facilities. Highway transport operators everywhere are seeking to increase their tonnage demands, but because of the limited resource of the single route operator as compared to the broader and more general need of the shipper, motor transport progress is being greatly retarded.

We believe that all of these scattered forces are now awaiting the centralizing influence of highway transport clearing houses, and recommend that the National Highway Traffic Association begin a campaign of analyzing, through the motor truck manufacturers to their sales departments, to all types of jobbers and wholesalers, through their national and state organizations, to organized traffic clubs through national and state organizations, to individualize commercial warehousemen through their National Association, and to all such organized groups that are now feeling the need of improved transportation resources, the great possibility of such improvement, through the establishment of highway clearing houses.

We recommend that the National Highway Traffic Association confer with the Inter-State Commerce Commission on the early development of inter-state motor transport regulations, especially in the adoption of such regulations as will be applicable in unifying individual state regulations.

We believe that in the enactment of state regulations, especially as to rates, schedules, and fixed routes, great obstructive errors have been and will continue to be made, that the activity of the Inter-State Commerce Commission in seeking applicable inter-state regulations will tend greatly to stabilize state regulations and that the establishment of highway transport clearing houses will develop the information upon which constructive state regulations may be enacted.

Swimming Pool Sanitation: The use of chlorine for swimming pool sanitation is described in technical publication No. 41 recently issued by Wallace & Tiernan Co., Inc., Newark, N. J.

Steel Curb and Gutter Forms: A 4-page pamphlet illustrating the use of steel curb and gutter forms for use on road and street construction projects, was recently issued by The Heltzel Steel Form & Iron Co., Warren, Ohio.

Construction News and Equipment

MECHANICAL DEVICES FOR HIGHWAY TRAFFIC REGULATION

(Editor's Note: Following is the text of the progress report of the Committee of the National Highway Traffic Association on Mechanical Devices for Highway Traffic Regulation as presented at the recent annual meeting of the Association, by Prof. Lewis W. McIntyre of the University of Pittsburgh, chairman of the committee.)

Conclusions

Traffic laws should be enforced on the street by uniformed policemen, but the administration of traffic departments should be in the hands of engineers.

All traffic devices should be designed to have a maximum of visibility.

The color red should not be used for traffic regulation signs, traffic control lights or anything except to indicate danger of the first degree.

There is a definite relationship between the color and the size of a traffic sign in order to secure maximum effectiveness.

Traffic regulation devices must be standardized as rapidly as possible.

Position lights are better than colored lights for traffic control signals.

A joint committee on traffic regulation should be appointed.

Stanchions should not be joined together with chains.

Traffic control devices should be so built as to remain where placed.

Mechanical devices used in traffic regulation must be practically infallible in operation.

One way streets should be indicated by painted arrows.

Wide streets should have separate traffic lanes indicated for fast and slow moving traffic by means of painted lines.

Congestion can be considerably relieved by the correct location of traffic signals with reference to the intersection.

The use of colored lights on semaphores should be abandoned in favor of the position light.

Automatically controlled traffic signals must have a minimum of moving parts and be simple in operation.

Flickering light beacons should only be used to indicate danger of the first degree.

Progressively controlled traffic signals will be more effective in relieving congestion than synchronously controlled signals.

Origin of Traffic Regulation

Traffic regulation originated when policemen were placed on Broadway for the protection of pedestrians from careless truckmen and omnibus drivers. The following quotation from James Blaine Walker's "Fifty Years of Rapid Transit" indicates the situation of that time.

Early New York Traffic Conditions

"According to figures compiled by Sharp in one of his campaigns for a franchise, about 230 omnibuses passed Chamber's street going up Broadway and 240 down each hour. For 13 hours this count, taken in August, 1852, showed that 3,035 omnibuses, and 4,719 other vehicles passed up and 3,162 omnibuses and 4,732 other vehicles passed down Broadway at this point. This meant an omnibus service at 13 seconds headway.

"By the year 1864, conditions had become intolerable. Broadway became unsafe for pedestrians, and we are told that the rivalry between omnibus drivers was so great that they recklessly drove over men, women and children in their haste to beat their nearest competitors to waiting passengers. Reckless driving and crowded omnibuses were not the only grievances. The drivers were accused of swearing at passengers and giving them bad money or tickets in change."

Enforcement of Traffic Laws

With the increase in traffic and the consequent growth of laws and ordinances affecting traffic, more and more policemen were naturally employed in their enforcement. Traffic laws are still and should be enforced upon the streets by uniformed policemen.

Development of Manual Control

It was soon observed that the presence of policemen had an unforseen result. It reduced accidents to vehicles and expedited travel. The control, however, was largely manual. Some of our large cities today use this method exclusively.

(Cincinnati for example) and in most of them it is used to some extent. When the regulation of traffic was first undertaken the efforts of the police were chiefly directed to stopping vehicles, but as they have gradually become more proficient and have acquired a better appreciation of the real purpose of traffic control, their aim has been to keep traffic moving. The raised hand to direct a stop is less frequent, while the arm motion to go ahead is more often seen.

Administration of Traffic Departments

The introduction of the motor vehicle has increased traffic to undreamed of proportions and made other methods of control necessary. The questions of accident prevention and traffic congestion are problems which demand for their solution minds carefully trained in analysis, the engineering type of mind. The administration of traffic departments, involving as it does the study of traffic problems and the making of regulations, should be in the hands of engineers.

Design of Traffic Signals

Few persons realize the importance of the traffic signal in increasing the speed of traffic movement and promoting the maximum volume of vehicle and car movement. However, the problem must be worked out scientifically in order to bring about this maximum movement. The various factors entering are not in any sense vague or indeterminate but must be carefully analyzed for each important intersection.

A Problem of Education

One of the principal problems in traffic regulation is the education of those to be regulated. Effective traffic control is dependent on public understanding and co-operation and if properly conducted it can be made largely automatic.

Mechanical Devices

Mechanical devices for the regulation of traffic must be analyzed from two points of view: safety and the relief of congestion. The following principles should be considered in their design.

Visibility

In detail this means that the upright portions of all stanchions, semaphores, etc., should be painted with alternate bands of black and white from 8 to 12 in. wide. It means that the base of such stanchions should be painted white. It means that the spot on the pavement on which they set should be painted white. It means that spot lights arranged to illuminate the base at night, and in the case of semaphores, the traffic officer is advantageous. It means that unlighted obstructions of every character should be denied a place upon the highway at night, be they stanchions, semaphore or mushroom.

Traffic Signs

Traffic signs should conform to this principle of maximum visibility. They should denote their meaning as far as possible by their shape and color. Probably the best combination consists of vivid yellow letters on a black background. Signs intended for moving vehicles should differ from those intended for stationary vehicles. The latter might have the the colors reversed, i. e., black letters on a yellow background. Signs of a tertiary character such as those for the control of pedestrians, street car stops, etc., might consist of black letters on a white background.

The writer recognizes that yellow does not represent the color of maximum visibility, that red is the most penetrating color. He would not use red on traffic signs, however, for reasons to be explained in the discussion of color.

Color

The use of red as a color for traffic regulation signs, traffic control lights, or for anything except to indicate danger of the first degree is to be depreciated. The promiscuous use of the word "danger" on such signs is also to be frowned upon. Familiarity breeds contempt and the motor vehicle user, having seen the red color used to indicate things which were not particularly dangerous or having seen the word danger quite frequently where caution or warning would have been more appropriate as indicating danger of a secondary or tertiary character, gives much less heed to this color or this word when they do indicate a real danger.

The use of the word danger in connection with advertising should be prohibited. For a driver to read that it is dangerous to go any further without a drink of so and so's coffee makes him much less alert when confronted with a real danger sign. Let us not forget the story of the "wolf."

Relation of Color and Size

The relation between color and size of traffic signs merits serious study. Psychologists tell us that concerning the bill board as used for outdoor advertising, there is a definite relationship between the size of the bulletin and the colors and tints used to secure maximum effect. Halving the size of that bill board will

change the character of the colors and tints which should be used. What is the proper size for various types of traffic regulation signs? The determination should not present insurmountable difficulty.

Uniformity

If we were to collect specimens of traffic control devices from those cities where traffic regulation is active we could fill a museum with signs and signals, no two of which would be alike in color, shape, size or marking. Such a collection would be the best kind of evidence of the need for uniformity. The result of the driver being faced with so many different types of direction is that he disregards all of them to a greater or less degree. In other cities, traffic devices are few and far between.

The citizen of Chicago should be able to obey the traffic rules of San Francisco as indicated by the mechanical devices employed without question. A red light on the traffic tower on Woodward avenue, Detroit, should not indicate stop while the same color indicates go on Fifth avenue, New York, nor a green light indicate go in Detroit while it indicates change in New York.

Standard Traffic Lights

As a suggestion looking toward standardization of traffic lights on towers, the writer would eliminate red for the reasons already named, viz., the reservation of this color for the indication of danger. We might then follow the standard colors in use by our steam and electric railway systems and also as partially adopted by the American Association of State Highway Officials, i. e., yellow, green and white as indicating varying degres of caution and a clear track respectively. Green might indicate stop, yellow change, and white go.

The Position Light

A better arrangement would be the use of position lights instead of colors. The Pennsylvania Railroad, among others, has adopted the position light in place of the old semaphore and colored light.

Such a system consists of a circular disc on which seven lights are placed in such a manner as to give three in a row, either horizontally, vertically or diagonally. Three lamps are lighted simultaneously giving three different possible combinations corresponding to the positions formerly taken by the semaphore arm, i. e., horizontal, verticle or inclined.

Color Blindness

This would eliminate the effect of color blindness in causing misunderstanding of traffic lights of this sort and would be more intelligible even to the total stranger because of its greater simplicity. The effect of color blindness is not such a negligible item as it might at casual glance seem to be. Four per cent of the male population of the United States are color blind to red and green.

As further evidence of this lack of uniformity the writer counted in Pittsburgh four different color combinations on traffic signs in one block, viz., white and black, red and white, blue and white, and yellow and black.

A Joint Committee

This much desired uniformity will not be advanced by having the committees on traffic regulation in various technical societies make individual recommendations with regard to these matters. A joint committee should be appointed with representatives from all organizations interested in the regulation of traffic. The report of such a committee would have much greater weight and be much more likely of universal adoption than the work of a committee from one organization. So numerous and of such infinite variety are the devices for the regulation of traffic rapidly becoming and so confusing is the result, that this subject may soon become the subject of national legislation unless a measure of co-operation is secured between various states and their lesser sub-divisions.

The delegation by many of our cities of the regulation of traffic to aldermen, commissioners and police officers of very limited experience in traffic work has contributed to this confusion. These men, not being content to profit by the experience of others, and frequently without inquiring into this experience, appear to have devoted most of their energies to devising some new form of installation.

American Engineering Standards Committee Report

In this connection the forthcoming report of the American Engineering Standards Committee on Traffic Regulation will undoubtedly be of considerable interest.

Chains

The joining together of stanchions and posts with chain and ropes is dangerous, and can not serve any purpose which the stanchions themselves would not serve. The chains are relatively invisible and are more likely to cause accidents than prevent them. A case in point is some of the safety zones recently adopted

in Detroit consisting of large posts painted white and joined together with chains.

Stability

All devices for the regulation of traffic should be of such construction that they will remain where placed. They should be sufficiently heavy to remain in place during a high wind. Their bases should not be round so as to avoid rolling if knocked over.

Simplicity

Any mechanical device on which the safety of so many people depends must be simple in construction and infallible in operation. Provision must be made for protection against burnt out lights, springs which become misplaced and broken, or any defect in the mechanism that will render the device inoperative. When once installed considerable dependence is placed on such devices and their failure is apt to be much more serious than if they had never been installed.

One Way Traffic

All one way traffic streets should be more plainly indicated than is frequently done at present. Probably the best way of doing this is by means of several large arrows painted on the pavement at each intersection. In lieu of painted lines, white cement blocks have been used in Portland, Ore. They are made of hydraulic cement and celluloid, are hard, tough, and have a glass like finish and are said to be permanent in color.

Traffic Lanes

On wide streets congestion is relieved by painting separate traffic lanes for slow moving and fast moving traffic, the lane for slow moving traffic being nearest the curb. Instead of paint the white blocks described above might be used.

Location

The location of the mechanical devices used merits considerable study. As a typical example it may be said that it is the general custom to place mushrooms and dummy cops in the centers of intersections, all traffic making a left hand turn being required to pass around them. This results in a very small turning radius and a consequently much reduced speed. Should not these markers be placed in the centers of the four property lines and the marker at the center of the intersection be eliminated? This would result in a much larger turning radius and nearly twice the vehicular speed. Neither would it result in vehicles dangerously cutting the corner. What this means in getting more vehicles through an intersection can readily be appreciated when we consider that even if vehicles cross an interesection with undiminished speed, the capacity of the intersection is but 50 per cent of the capacity of either approaching street.

Or where should traffic towers be placed? In the center of the intersection as in Detroit, or behind the property line as on Fifth avenue, New York, and what are the relative advantages of each position? Towers might be placed above the center of an intersection and still not obstruct that intersection by being mounted from a bridge supported on pedestals on the adjacent sidewalk or from adjoining buildings. A clear view of the tower could then be had from both main and cross streets.

Classification

Mechanical devices for the control of traffic can be further classified according to their method control under four general headings: Manually controlled devices, automatically controlled devices, semi-automatically controlled devices, and synchronously controlled devices.

Manually Controlled Devices

Under the first heading, that of manually controlled devices, we can place all standards, dummy cops, semaphores and certain types of mushrooms, standards and dummy cops.

An application of the principles above set forth of visibility, color, uniformity, simplicity, use of chains and stability should make the satisfactory design of such devices a simple matter. Yet how often are these principles violated. The writer recalls a recent experience related by a friend in his home city. While driving into the entrance to one of the parks at dusk, he observed a machine going in the opposite direction, making a terrific racket, and dragging what appeared to be its whole rear end on the road. On going a little farther the trouble was easily diagnosed. A few days before the police had placed down the center of the roadway a series of standards bearing signs "Keep to the Right.' The bases of the standards were round and black in color. The upright portion was also painted black, the signs had white letters on a red background, they were connected with chains and were unlighted. When my friend saw them they were also scattered all over the road.

Semaphores

The number of existing types is legion. The simplest type may be said to be the beach umbrella with the words stop and go painted on the sides and con-

trolled by the traffic officer underneath, who is usually in as much doubt regarding the reading of his signs as the vehicle driver is concerning whether to stop or proceed. The correctly designed semaphore has been partially described in discussing the principle of visibility. In addition it should have lights mounted on the ends of the semaphore arms indicating their position at night. The writer would not see a light on top of the semaphore standard.

The semaphore arms themselves should conform in color to the principles already indicated and should be constructed so that they can be placed in a neutral position when no traffic officer is on duty. If in addition the traffic officer is provided with a small light on his chest, we have the maximum in visibility, clearness and stability.

Mushrooms

Mushrooms or buttons serve a useful purpose in outlining safety zones and traffic paths. They should be very strongly constructed because they are occasionally run over by very heavy vehicles. They should never be placed upon the highway unless capable of being lighted at night. Their visibility should also be increased by the frequent use of white traffic paint. The type which disappears when struck by a vehicle would seem to be advantageous provided that under service they prove to be mechanically stable.

Automatically and Semi-Automatically Operated Devices

The automatic and semi-automatically controlled devices differ only in that the latter is capable of being operated manually or automatically at will. Under this heading we can place lighthouses, certain types of mushrooms, traffic lanterns, and traffic vanes. One of the principles involved is that every so often the signals change, thus allowing traffic to pass first in one direction, then in the other, the period of change being entirely controlled by the mechanism. The usual signalling is done by means of lights of various colors, either placed in mushrooms situated variously about the intersection, in traffic lanterns suspended over the intersection or attached to poles at the curb line or by a combination of the two. One device, however, consists of an arrow with the word stop on both sides. It is suspended in the center of the crossing by overhead wires and rotated by a motor directly above it. A whistle blows while the arrow is moving. It is illuminated at night and can be operated either from a box at the curb line or from fire headquarters. By such central control a complete route can be cleared in case of necessity.

Lighthouses

The other principle involved is that of the flickering light. The actual device varies, some being lights placed in mushrooms, some on standards, some electrically lighted and operated, and some lighted and operated by gas. Advocates of the use of these devices claim that the intermittent flashing light stands out sharply and distinctly from all other lights and commands attention. This is undoubtedly true. Opponents, however, claim that it distracts the attention of the driver and produces fatigue particularily at a time when he should concentrate on possible danger. The writer heard one highway commissioner state that he would give every lighthouse in his state to anyone who would pay the freight on them, and another commissioner from a different state as quickly replied that he would pay the freight.

A combination of the lighthouse and illuminated mushroom or button is used in central islands in large intersections when rotary traffic is instituted.

Flickering Light a Good Danger Signal

The writer believes that the use of such beacons should be confined to danger signals, indicating danger of the first degree and installation be permitted only under the strict supervision of the highway authorities. He also depreciates their installation as advertising mediums. As marine signals they have undoubtedly proven desirable and dependable. The highway signal is capable of somewhat further development.

In all such devices as have been mentioned, emphasis must be placed on simplicity. The device with a large number of moving parts and doing a number of different things should be scrutinized very carefully.

Synchronously Controlled Devices

The increasing congestion in our larger cities and the nearness with which our streets are reaching their capacity has made it desirable to control traffic in larger units than the single block. This has caused the development of the various synchronously controlled devices, practically any of the devices using lights being capable of this method of control.

The Traffic Tower

The foremost example of this type of device is the traffic tower or crow's nest used either by itself or in combination with traffic lanterns and mushrooms. This is the most difficult type of traffic regulation.

As usually practiced this type of control has simply minimized the delays in starting and stopping at cross streets, through the visibility of the signal over greater distances and through the movement of a somewhat larger unit than the single block. It has by no means reached the limit of its possibilities. It should be possible through accurate counting and charting of the traffic at each intersection to determine the exact length of time required for the traffic to pass through that intersection, every way, at every time of day.

Platoon Control

By a carefully worked out scheme of progressively changing the traffic lights along the main thoroughfare, instead of synchronously changing them, traffic might move in platoons, so that a vehicle once having joined a platoon would remain in that platoon throughout the length of its journey. This platoon having once started would not stop until it had traversed the complete length of the main thoroughfare, except in case of emergency. Depending upon the speed this platoon was permitted to have, either the maximum capacity of the thoroughfare could be obtained, or the minimum length of time taken to traverse the length of the thoroughfare. This itself could be varied depending on the time of day.

Master Streets

In most cases it will be found that a large degree of control will be exercised on traffic on the main thoroughfares by certain master cross-streets such as 42nd Street, New York. By the progressive change of the traffic signal, however, the influence of this master street would be minimized and traffic having passed it would no longer be under its influence.

Cumulative Effect of Traffic Delay

The write desires to call special attention to the cumulative effect of a traffic delay. This is illustrated by a recent investigation on the Interborough subway. It was found that the delay of one train two minutes resulted within one-half hour of every train on the system being ten minutes late.

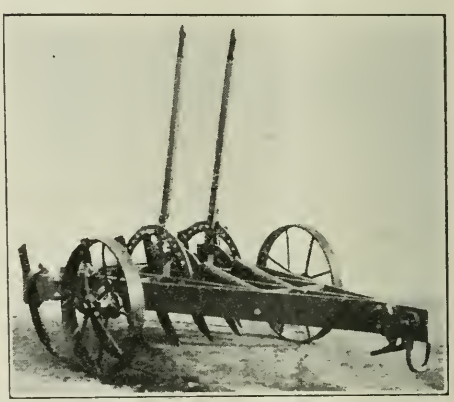
Painted Lines

One feature of the painted line in assisting traffic which the writer has never heard mentioned is its value in helping overcome the effect of glaring headlights. The reason why the bright head light is so serious is that the driver coming from the opposite direction looks directly at it. I have found that it take a conscious effort to look away. In cities the situation is further complicated by the many other distracting lights.

The painted center line supplies something for the driver to focus his attention upon with the assurance that as long as he remains on his side of the line he will pass the cars coming from the opposite direction in safety.

THE LAKEWOOD GRADEROOTER

The Graderooter is a new piece of paving equipment brought out this season by the Lakewood Engineering Co., of Cleveland. This machine, here illustrated, has been found particularly useful in scarifying the subgrade preliminary to mechanical subgrading. It is used also for practically all of the scarifying work



THE LAKEWOOD GRADEROOTER

found on the average road job and is built very heavy to stand up under severe service. Some contractors are using it in place of a rooter plow. It is also being used for maintenance work by state as well as county highway departments.

The graderooter is furnished with two sets of five teeth each, and one special manganese tooth alone for particularly heavy work. The machine weighs about 1,300 lbs. and can be furnished for tractor or team hitch.

NEW SIZE P. & H. GASOLINE SHOVEL

A 1 yd. capacity shovel, operated either by gas or electricity, has been brought out by the Pawling & Harnischfeger Company, of Milwaukee, Wis. The new machine is very similar in design to the P. & H. ½ and ¼ yd. machines, which are being so widely used in all parts of the United States and even in India and Japan.

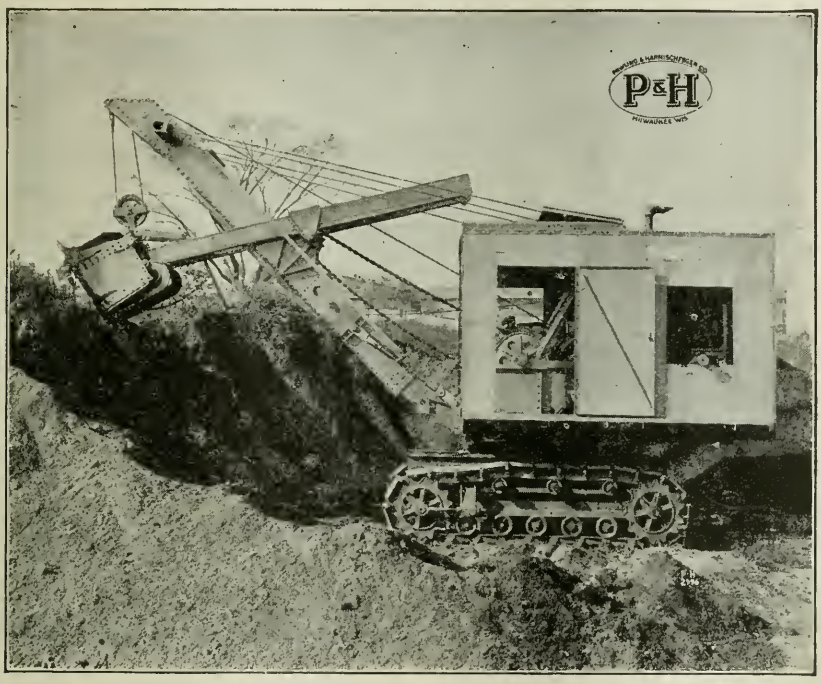
Being driven by gasoline or electric motor the machine is operated by one man, no fireman being required. The saving in this one man's wages alone is considerable.

tor to bite into the heaviest digging.

The machine is designed to come within standard railway clearances with only a minimum amount of dismantling. This is a very important feature for machines that have much moving to do.

The shovel is mounted on P. & H. corduroy traction, so called because it really lays its own corduroy road. The traction is very rugged being built entirely of steel and is non-cloggable even in the heaviest going.

A large southwestern railway system is using two of these machines with gasoline motors on new right of way construction; a large stone quarry has purchased one with electric motor; and irri-



THE NEW SIZE P. & H. GASOLINE SHOVEL.

Another excellent feature of the gasoline or electric drive is the practical elimination of fuel and water hauling expense. Another advantage is the ease of operation in inaccessible places.

The crowding motion of the 1 yd. shovel is of the standard P. & H. design. A manganese rack on the dipper stick is driven by a heavy thimble roller chain from a set of planetary gears. These gears are mounted on the forward drum of the machine. This gives a positive crowding motion regardless of the position of the dipper and enables the operagation district in the Southwest has also purchased one.

In addition to being used for a shovel, by a simple change of booms, this machine is used with drag-line, clam-shell, pile-driver, crane hook, etc.

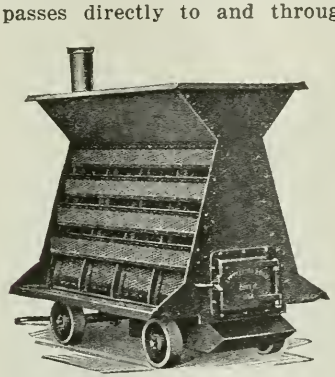
GRAVEL HEATER AND DRYER

The Littleford Gravel Heater and Dryer No. 74 is manufactured under the C. A. Mullen patent, and makes use of a very simple principle, whereby the combined power and heat and ventilation make dry-

ing and heating very rapid and thorough. It will heat all kinds of crushed stone and gravel, but because of its construction, can not be used for sand. It is adaptable for use by paving and building contractors, roofers, street railways, maintenance departments, etc. It is indispensible for winter concreting when large quantities of hot materials are needed.

The heater and dryer is made entirely of plate steel and consists of a large fire chamber with sloping walls of perforated steel extending upward to a point at the base of the charging hopper. At different levels but uniformly spaced from these walls are additional perforated walls or flights.

In operation, the material to be dried is loaded into the hopper at the top from which it feeds by gravity into the open flights on both sides of heater . As it is suspended, in a thin layer, against the perforated sides of the fire chamber, the heat passes directly to and through it



THE LITTLEFORD GRAVEL HEATER AND DRYER NO. 74.

carrying away every particle of moisture. Hot dry material continually feeds to the base where it can easily be removed.

This equipment is mounted on heavy steel wheels and axles which are machine turned and fitted with standard axle nuts. A suitable handle is provided for drawing it about. It is made in two sizes which have heating capacities of two and four tons per hour. It is manufactured and sold by Littleford Bros., 460 E. Pearl St., Cincinnati, Ohio.

TRADE NOTES

The American Gas Accumulator Company, of Elizabeth N. J., who make traffic beacons and highway lighthouses, have opened a New York office at 100 East 42nd Street, in the new Pershing Square Building opposite the Grand Central Station. In an effort to solve the traffic problem and reduce the number of automobile accidents, this company has developed a traffic engineering department which makes a survey of municipal traffic conditions, bringing to bear known engineering principles in other fields. It is an interesting point to know that these flashing traffic beacons and highway lighthouses operate in the same manner as the government buoys and lighthouses in the harbors of the United States, and other parts of the world. They are sister lights to the recently installed aviation routing beacons of the U. S. air mail service, located every three miles from Chicago to Cheyenne to guide the transcontinental night flyers.

A gasoline impact drill of the air hammer type is now manufactured by the Pennsylvania Gasoline Drill Co., Land Title Bldg., Philadelphia, Pa. The drilling unit is a self-contained, portable, gasoline hammer, so powerful and compact that one man operates and transports it from place to place. Like the self-contained gasoline engine, this gasoline hammer makes its own power, therefore no other power equipment has to be transported with it. When first seen in operation, the lack of connection to other agency of power causes wonder and forcefully brings a realization of the terrific power of gasoline when applied directly to the hammer piston of this drill. The drill is a demonstrated success and is so regarded by large users of drilling equipment.

A new type of deep well pump has recently been perfected by the Worthington Pump & Machinery Corp., 115 Broadway, New York, operating on a principle heretofore not used in pumps of this kind. Although the pump is of the rotary class the water is not elevated by means of a conventional type of impeller but a form of propeller is used very similar to that employed for propelling ships.

The Chausse Oil Burner Company has been incorporated to manufacture oil burning apparatus for asphalt street repairing, for installation in electric railway cars, for production of house furnace burners and the manufacture of oil burning hand torches. The Company is incorporated for $100,000 and its officers are: W. McK. White, president; W. G. Chausse, vice-president; Wray P. White, secretary. Offices have been opened at 206 Lincoln Building, Detroit, Mich., and plans are being made for the location of

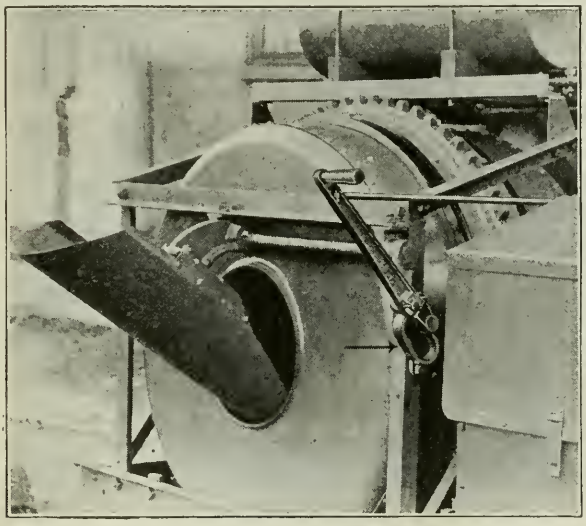
a factory either in Detroit or in a nearby city. The apparatus which the Chausse Company will make has been produced in a small way for several years for use by steam and electric railways, street paving contractors and municipal boards of work. The 3 gal. Chausse torch has been a standard in steam railway signal departments for several years in use for thawing switches and signal mechanism.

IMPROVEMENT IN MIXER CONSTRUCTION

One of the interesting improvements noticed in the construction of concrete mixers this year is the new device used on the 7-S mixer made by the T. L. Smith Co. of Milwaukee, for operating the discharge chute. The simplicity of this mechanism is shown in the accompanying illustration.

The operating lever is pivoted to a short arm that is keyed to the shaft to which the chute is attached. When the operating lever is moved, a small roller, attached to the end of the lever, follows the outline of a cam that is bolted to the mixer frame. Except for the rod which extends across the mixer to enable the chute to be operated from the other side, these few simple parts constitute the complete discharge operating mechanism.

In the illustration the lever is shown in its extreme forward position. The chute is locked securely in the position for mixing and where it in no way interferes with the mixing action. Pushing the lever back moves the chute into the discharging position. In the full discharge position the chute is locked and does not have to be held. The peculiar shape of the cam provides the locking feature in each position, no other arrangement being necessary. Releasing the chute from either position is merely a part of the operation of moving the chute from one position to the other. The operator simply takes hold of the handle and moves it forward or backward, according to the position of the chute. By this new method the chute operates easily and quickly.



NEW DEVICE FOR OPERATING DICHARGE CHUTE OF SMITH MIXER.

THE LITTLEFORD TRAIL-O-HEATER

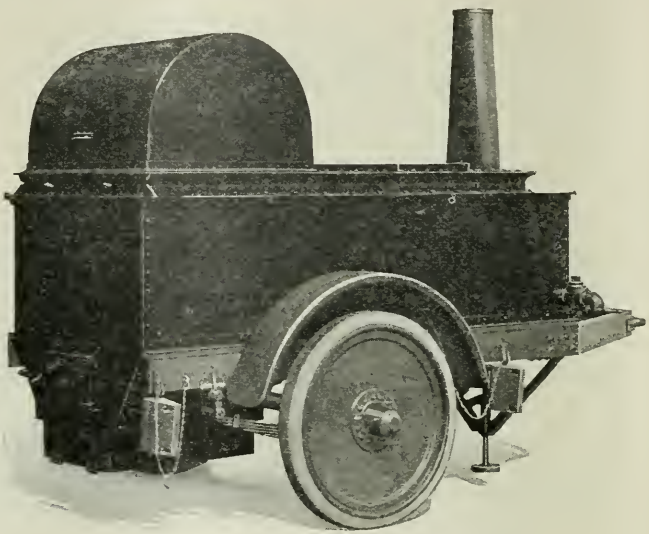
The problem of what to do with the many army trailers now lying unused in the storage yards of the state and county departments and cities has been solved by Littleford Bros., 460 E. Pearl St., Cincinnati, O., who have designed a tar and asphalt heater which is expressly made for mounting on the army trailer chassis.

The placing of a tar and asphalt heater on a spring suspended chassis with rubber tires and roller bearing wheels has solved transportation problems which in the past had limited the use of this kind of equipment. With this superior running gear, a tar and asphalt heater can be trailed behind rapidly moving vehicles

in safety, which enables the highway department to cover more mileage and do better work.

With this equipment, where the "patrol system" of maintenance has been inaugurated, the repair gangs will cover their districts more frequently and with greater efficiency and economy, and when not used in this capacity it is large enough to be used at the central mixing plant.

The kettle of this heater has a capacity of 300 gals. All seams are electric welded. A 2 in. draw-off valve is provided on each side. The cover is arranged with a warming hood under which a barrel of tar or asphalt may be placed for draining. The furnace shell completely surrounds the kettle. It is supported on each side and bolts securely to the chassis frame. It has a large fire box with an improved type fire door and renewable grate bars conveniently located at the rear. It is provided with a large ash pit and draft control door.



THE LITTLEFORD TRAIL-O-HEATER.

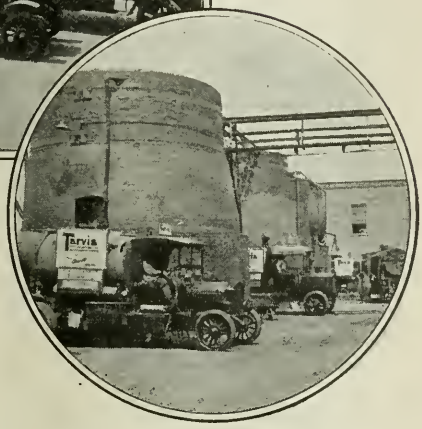
TRADE LITERATURE

Road Machinery—Improved road making, maintenance and earth handling machinery is illustrated and described in a 32-page, 6x9 in. catalog, entitled: "Signs of Better Roads," recently issued by the Austin-Western Road Machinery Co., Wrigley Bldg., Chicago. The following equipment is covered: road graders, back slopers, grader-scarifiers, double-ender, elevating graders, road oilers, culverts, the "pup" roller, maintenance machinery, road drags, wheeled scrapers, drag scrapers, fresno and tongue scrapers, plows and ditchers.

Austin Double-Ender—The Austin double-ender, characterized as the most useful road grader improvement of recent years, is illustrated and described in an 8-page, 6x9 in. pamphlet, issued by the Austin-Western Road Machinery Co., Wrigley Bldg., Chicago. This is a simple but powerful attachment permanently connected at both ends of the grader blade. Its use increases the amount of work the grader can do and the number of functions the grader can perform. It is made for every size Austin grader. When not in use the attachment is tucked back of the blade and is not in the way. When wanted the extensions are swung forward and a bolt dropped in the quadrant hinge holds them out. This increases the length of the 12 ft. blade to 18 ft.

Irrigation Pumping—The pumping and water distributing system of the Lindsay-Strathmore irrigation project in Tulare County, California, is described in a well illustrated leaflet issued by the De Laval Steam Turbine Co., of Trenton, N. J. This district is an irregular tract on the foot-hills of the San Joaquin Valley, 62 miles south of Fresno, and contains 15,500 acres, of which 8,000 are planted with oranges and lemons. The water supply is obtained by pumping from wells in the delta of the Kaweah River, and is lifted to the high level flumes and pipe lines by large centrifugal pumps driven

A fleet af Tarvia Motor Trucks at the Chicago Plant



"What Do You Mean by Tarvia Service?"

HUNDREDS of men interested in the building and maintenance of good roads have asked us this question. Here is the answer:

First of all, Tarvia Service means that we put at your disposal the skill of highly trained road engineers—men with years of experience in all types of road construction. Without obligation, these men will assist you in solving your road problems — construction, maintenance or repair.

The next phase of Tarvia Service—and a most important one—is the prompt dependable delivery which the strategic location of our branches assures. Moreover Tarvia is shipped in the form most practical to your requirements—by our own fleet of tank cars, in barrels or by motor trucks.

Where it is delivered by motor trucks, we follow a truck-dispatching schedule as punctual and dependable as that of the great trans-continental trains. These trucks are manned by trained experienced crews who lend their skilled co-operation in the application of the Tarvia.

In brief, Tarvia Service is a real aid to the road officials of any state, city, town or community where prompt, efficient road construction is the need. A line to our nearest branch office will start the wheels moving.

Tarvia
For Road Construction Repair and Maintenance

The Barrett Company

New York	Chicago	Philadelphia	Boston
St. Louis	Cleveland	Cincinnati	Pittsburgh
Detroit	Kansas City	Birmingham	Dallas
Minneapolis	Salt Lake City	Bethlehem	Lebanon
Youngstown	Milwaukee	Toledo	Columbus
Baltimore	Syracuse	New Orleans	Rochester

THE BARRETT COMPANY, Limited
Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

by electric motors receiving power from a long-distanced transmission line. It is well brought out that by good engineering and the use of modern, large and highly efficient pumps, irrigation can be introduced in extensive tracts that were formerly either too distant from or too high above the water supply to make their development profitable.

Road Oilers, Sweepers and Sprinklers—The Austin line of road oilers, sweepers and sprinklers is adequately presented in Catalog H, issued by the Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago. This is a handsome catalog of 40, 9x12 in. pages. It illustrates road oilers, heater attachment, oiler units, trailer units, street sprinklers, sprinkler units, street sweepers, sprinkler-sweepers, brooms, motor sweepers and other Austin machinery. The catalog gives much valuable information on road oiling, street sweeping and sprinkling, etc.

Segment Sewer Blocks—Official Test Data on Laclede-Christy Segment Sewer Blocks are presented in a bulletin issued by the Laclede-Christy Clay Products Co., St. Louis, Mo. The results of tests made by Prof. J. L. Van Ornum, of Washington University, St. Louis, are given in detail.

Water Softening Equipment—Graver Zeolite Water Softening Equipment is described in Bulletin No. 509 issued by the Graver Corp., East Chicago, Ind.

Portable Elcctric Tools and Shop Equipment—The Black & Decker line of portable electric tools and shop equipment is presented in Catalog No. 5 issued by the Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. The line includes: electric grinders, valve grinders, screw drivers, electric bench and pedestal grinders and electric air compressors. The catalog contains 32, 8½x11 in. pages, and is attractively printed.

Trailers—The use of trailers for reducing hauling costs in modern freight transportation is illustrated and described in a catalog issued by the Detroit Trailer Co., 954 E. Milwaukee Ave., Detroit, Mich. Trailers are shown for the hauling of milk, lumber, coal and merchandise. This company also builds a passenger bus trailer which will carry 80 people safely at a speed of 18 miles per hour, it is claimed.

Excavating Equipment—The Pawling & Harnischfeger Company, Milwaukee, Wis., Manufacturers of Cranes and Excavators, have recently issued new bulletins featuring P. & H. Excavating Equipment. Their 58-X Bulletin features the clamshell, dragline, orange peel, backfiller, crane hook, electro magnet and pile driving rig, with which the P. & H. Excavators may be equipped. The 16-X Bulletin features P. & H. Trenching Machinery. Their Testimonial Bulletin is made up of a series of letters written by a few of the many users of P. & H. Machinery.

Excavator and Loader: "Smith Excavator and Loader" is the title of an attractive, 20-page, two-color catalog just issued by The T. L. Smith Company of Milwaukee. In addition to the usual description, illustrations, and specifications of the excavator and loader, there are several pages devoted to the five uses for which the machine is designed, namely, (1) Basements and general excavating and loading; (2) Bank excavating and loading of gravel, sand, etc.; (3) Stock pile loading of gravel, sand, coal, etc.; (4) Stripping of sand, gravel, clay and rock; (5) Grading of alleys, streets and general work. The new catalog also contains facsimiles of seven letters from contractors who own and operate Smith Excavators and Loaders, together with numerous illustrations of these machines on typical jobs.

Truscon—I Construction: A recent important advance in construction methods for large buildings is the Truscon—I Construction described in literature issued by the Truscon Steel Co., Detroit, Mich. Combining the essential advantages of both reinforced concrete and structural steel, this type of construction has been successfully used in large buildings in all parts of the country. It retains the economy of steel inherent to reinforced concrete but eliminates the expense and inconvenience of form work. It has the self-sustaining qualities of structural steel but eliminates its excessive steel tonnage. Although publicity has not heretofore been given to this type of construction it is now definitely established as shown by the fact that millions of square feet of it are in successful use. The pamphlet "Truscon—I Construction Illustrated" shows the character of the work and quotes some of the endorsements it has received. Many authoritative tests have been made on this construction and some of the facts and figures derived from these tests are summarized in a book issued by the Truscon Steel Co., entitled "Load Tests." Generally this construction has the approval of the building departments of principal cities.

Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—Nixon & Phillips, Lineville, Ala., awarded contract by State Hwy. Dept., to build 2 rd. projects as follows: Henry Co., 11.799 mi. sand and clay rd. from Abbeville no. to County line, at $68,652; Barbour Co. 13.537 mi. sand and clay rd. from so. west cor. of Co. thru Clio, to pt. 5 miles no. east of Clio toward Clayton, at $67,383.

Ala., Montgomery—State Hwy. Dept. let contracts for grading and gravel surfacing 25 miles road from Opp to Florala, Covington Co., to Stanley & Singer, Lafayette, at $244,291; 10 miles bet. Evergreen and Bellville. Conecuh Co. to Keenan & Kyser.

Ark., Little Rock—Oliver Constr. Co., Little Rock, awarded contract to grade and gravel surf. 14 miles Perryville rd. bet. Forest Park and Prothro's Camp ground, at $154,600.

Cal., Calipatria—G. W. Cushing, Richmond, Cal., (also 1501 Brook Ave., San Diego) awarded contract by City Trustees, for paving Main St. and Holabird Ave., at abt. $80,902.

Cal., Long Beach—Two Miracle Concrete Corp., Great Falls, Mont. (temp. address, Alexandria Hotel, Long Beach) awarded contract at approx. $486,000 for improving streets and constructing storm and san. sewers in Dist. 4, or the Belmont Shore Dist., involving 870,746.91 sq. ft. 5-in. concrete paving including grading at 27c ft.; 33,610.19 ft. curb at 70c ft.; 168,573 sq. ft. walk at 21c ft. Contr. also includes storm drain requiring 10,923 ft. reinf. conc. pipe 6-in. to 42-in. diam.; san. sewer requiring 54,326 ft. cem. pipe from 8-14 in. diam., 1,377 ft. 12-in. cast iron pipe, 202 manholes, 4 flush tanks, 71 lampholes and 78 catch basins also sewage pumping plant with pneumatic ejectors costing $22,400.

Cal., Los Angeles—Geo. H. Oswald, 366 E. 58th St. awarded contract for impvt. of Diaz Ave.—Rita St. to Ventura Blvd.—at $45.111, involving grading at $6,500 (lump sum,; 194,772 sq. fe. Topeka paving at 19.4c ft.; 290 sq. ft. grading and oiling at 9c ft.; storm drain complete, $800. H. H. Peterson, Loma Portal, awarded contr. by Co. Supvrs., for impvt. of Ocean Ave. bet. east City limits of Long Beach east to Avenue 19 at $60,700.

Cal., Santa Ana—Steele Finley, Santa Ana, awarded contract by Co. Supvrs., for road constr. in Rd Imp. Dist. No. 20, La Habra, at $199,640.

Ct., Hartford—E. Balf & Co., State St. awarded contract for paving 6,100 ft. Park St., 3-in. asph. on 6-in. base. Engr.'s est. $156,000; 2613 ft. Broad and Webster Sts., 40 ft. and 30 ft. respect., 3-in. asph. on macadam. Est. $42,000; 3,285 ft. Wash., and Ann Sts., 41 ft. and 10 ft. respect., 3 in. asph. on 6-in. conc. Est. $65,000; patching 10,000 sq. yds. Est. $26,000.

Conn., Manchester—E. Balf, 26 State St. Hartford, awarded contract for paving 4,000 ft. Main St., 80 ft. 3-in. asph. on 6-in. concrete, at $92,000.

Fla., Lake City—C. F. Lytle, Jacksonville, Fla., awarded contract to hard surface with concrete 2 sects. of road No. 2, so. of Lake City, Columbia Co., Proj. Nos. 27-A and B, at $493,926.

Fla., Miami—T. B. McGahey Co. awarded contract at $300,000 for $158,268 sq. yds. bitum. pavement, penetration; J. F. Morgan & Co., at $300,000 for 75,887 sq. yds. sheet asph. paving. Both contractors located in Miami.

Fla., Miami—Bunnell & Cail, awarded contract to lay 75,498 sq. yds. concrete sidewalks, at $150,000.

Fla., Tallahassee—Barber-Fortin Co., Gainesville, awarded contracts for constr. of broken stone base course on 5 mil. rd. bet. Sharpes and Titusville, Brevard Co., 5 miles road betw. Bonaventure and Eau Gallie, Brevard Co. and 14.4 miles bet. Bunnell and Volusia County line, Flagler Co., at $89,326, $87,930 and $186,900, respectively.

Ga., Atlanta—State Hwy. Comn., let contracts for 6 road projs. as follows: Polk Co. 5.03 mi. chert rd. to R. L. Killian Co., at $104,525; White Co. 9.996 mi. top-soil rd. to Nichols Constr. Co. at $86,862; Bibb & Wayne Cos., 7.1 miles sand clay rd., also 11 creo. timber brdgs., and 100 ft. steel span brdgs. to Dales & Co., at $57,739; Lumpkin Co., 3.32 mi. top soil rd. to T. P. Wright, Atlanta, at $28,153; 1.64 mi. in Echols and 4.01 miles in Lowndes Cos., to Bryson Livestock Co., Jacksonville, Fla.

Ind., Indianapolis—McCoun Constr. Co., Noblesville, awarded contr. by Marion County Commrs., for constr. of 5-mile conc. pavement on Michigan Rd. northwest of Indianapolis, at $196,643. Contract calls for use of Indiana stone.

Ia., Manning—J. S. McLaughlin & Sons, Mankato, Minn., awarded contract for paving, curbing and guttering here, at $155,480.

Ky., Whitesburg—Commofori Constr. Co. Whitesburg, awarded contr. for constructing 8 miles highway from Whitesburg to Harlan, Letcher Co., at $112,000.

Ky., Frankfort—State Hwy. Comn., let contracts to grade, construct draining. structs., etc. on 8 roads as follows: Morgan Co., 15.925 mi. W. Liberty-Frenchburg Rd., to Ellis & Smeathers, Owensboro, Ky., at $198,125 for rein. conc. pipe; Kenton Co., 10.282 mi. Covington-Falmouth rd. to Herman Hughes Constr. Co., Cincinnati, O., at $344,550 for rein. conc. surf., with conc. pipe. Central City-Calhoun Rd., from end of State Proj. 10 to McLean Co. line, Muhlenberg Co., 4.37 miles Central City-Calhoun Rd.—end of St. Proj. 10 to McLean Co. line to J. C. Ellis, Owensboro, at $21,803 for impvts. with rein. conc. pipe; Henry Co., 3.917 mi. New Castle-Shelbyville Rd.—New Castle to Eminence—to Berman Adams, Winchester, Ky., at $37,273; waterbound macad. with local stone. Webster Co., 3.879 mi. Dixon-Henderson Rd.,—Henderson Co. line to end of FAP 34, to W. C. Carter, Clay, Ky., at $21,029; rein. conc. pipe; Webster Co., 4.915 miles Dixon-Madisonville Rd. from Hopkins Co. line to end of FAP 34 from J. C. Ellis at $31,136 for rein. conc pipe; Harlan Co. 5.905 mi. Harlan-Pineville rd.—Wallins to Bell County line, from Eastern Constr. Co., Harlan, Ky., at $77,797, for rein. conc. pipe.

Ky., Frankfort—R. B. Tyler & Co., Louisville, awarded contracts to improve 2 roads as follows: Hardin Co., 6 miles, Western Dixie Hwy.—Red Mill to Hart Co. line, waterbound macadam surf. at $42,179; 9 miles watebound macad. surf. on Western Dixie Hwy.—so. corp. limits of Elizabethtown to 9 mi. so. and nr. Red Mills, at $65,154.

La., Alexander—A. E. Perry, Colfax, La. awarded contract to pave 5th St.—Scott to St. Ann Sts.; pave, lay walks and curbs and construct storm sewer on 7th St. from Monroe to Casson, at $150,399.

La., Colfax—A. E. Perry, Colfax, awarded contract for paving 5th St.—Scott to St. Ann Sts.—vertical fibre brk. on conc.; also storm sewer in 7th St. at $150,400.

Md., Baltimore—P. Flannigan & Son, Harford Rd. & Balt. & Ohio R. R., awarded contract for 21,010 sq. yds. Contr. 234NA. asph., at $91,136.

Mass., Boston—L. Carchia, West Roxbury, (Boston, P. O.) awarded contract for bitum. macadam paving 3.75 miles rd. 18-20 ft. in Burlington bet. Woburn and Billerica, at $131,919.

Mich., Grosse Pointe—(Detroit P. O.)—G. R. Cooke, 1260 Penobscot Bldg. Detroit, awarded contract for grading and paving 18,350 sq. yds. Neff Rd., sheet asph. on 6-in. conc. with conc. curb, at $100,000.

Mich., Holland—Richard Overweg, City Clerk, let contract to H. J. Glovver & Son, Muskegon, Mich., for 75,000 sq. yds. asph. pavement, at $202,708.

Mo., Jefferson City—Following contracts let by State Hwy. Dept.; to grade, construct drainage structs., etc.: Callaway Co., 2 sections to Tim Ryan & Sons, Missouri Valley, Ia.; 5 miles from Fulton to Jeff. City, St. Proj., Route 15, Sec. 48, at $22,571 and 3.655 mi. from Fulton to Jefferson, St. Proj., Route 15, Sec. 49 at $13,363; Clay Co., 3.171 mi. conc., from N. Kans. City to Excelsior Springs, St. Proj. Route 10, Sec. 1, to Highway Constr. Co., Webb City, Mo. at $97,196; Stoddard Co., 2.898 mi. conc. from Fisk to Porter. St. Proj., Route 16, , Sec. 83, to Service Construction Co., Poplar Bluff, Mo., at $104,738.

Mont., Great Falls—Fitzgerald & Staunton, Great Falls, awarded contr. for 11 miles gravel surface bet. Cascade and Ulm, at $80,366.

Neb., Beatrice—Abel Constr. Co., 318 Terminal Bldg., Lincoln, awarded contract for asph. concrete paving at $80,000.

Nev., Carson City—Dodge Bros. & Dudley Contg. ., Fallon, Nev., awarded contract for constr. of ec. F. Rte. 6, state hwy. in Clark Co. bet. Crystal id west slope of Mormon Mesa, 20.72 miles at 85,181.

N. J., Morristown—C. H. Winans Co. 205 Broad . Elizabeth, awarded contract by Morris Co. for ving 2½ miles Valley Rd. amesite on conc., at 18,773.

N. Y., Oneonta—W. P. McDonald Constr. Co. 17 . 42nd St. N. Y. City, awarded contract for rbing, guttering, asph. conc. and rein. conc. vements, etc., at $204,337.

N. Y., Troy—Fitzgerald Bros. Constr. Co., Inc., roctor Bldg., awarded contract for repairing asph. vements at $3.10 per c. y., and $13 per ton for nder, total $25,000; conc. paving 2nd Ave. to elmar Contg. Co. Inc., 401 Proctor Bldg., at 57,057.

N. C., Raleigh—Following contracts let by State wy. Comn. for 12 road projects: Chowan-Perimans Cos. 11.83 mi. hard surf. to Smith Bros. c., Dallas, Tex. at $296,635; Columbus Co., 12.89 i. hard surf. bet. Brunswick Co. line and Bolton Jas. O. Hayworth, Chicago, Ill., at $265,013; artnett Co., 10.74 mi. soil rd. to F. P. Holder, efferson, Ga., at $52,800; for roadway, and to T. J. ewell, Clinton, N. C. at $49,646 for bridges; range Co. 10.74 mi. grading to Dicuss Bros., Sanrd, N. C., at $50,107, and for brdgs. to Richards ros., Raleigh, at $17,693. Wake Co., 7.81 mi. rading and structs. to C. G. Kershaw Contg. Co., irmingham, Ala., at $36,788 for roadway, and T. Newell at $47,703 for structs.: Randolph Co., 97 mi. hard surf. to Allport Constr. Corp., Richmont, Va., at $279,931; Cabarrus Co., 8.59 mi. soil l. bet. Mecklenburg Co. line and Stanly Co. line Lee J. Smith, Charlotte, N. C., at $40,557, for oadway and to W. M. Lefler, Wadeville, N. C., $67,409; Ashe Co. 3.53 mi. hard surf. from Jefferon Orion to Overstreet & Nance, Bedford, Ga., at 08,431; Haywood Co. 11.66 mi. hard surf. to A. J. Vardrep, Knoxville, Tenn., at $372,415; Madison o., 6.71 mi. shale rd. to Reynolds Constr. Co., White Pine, Tenn., at $103,459 for roadway, and Moore Concrete Products Co., Andrews, N. C., $63,784 for structs.

N. D., Fargo—Birch & Sons, Fargo, awarded ontract for 40,000 sq. yds. bitulithic paving on ollege Ave., 9th Ave. N. and 10th St., at $47,671, 3,353 and $37,824, respectively.

O., Euclid—Cleve'and Trinidad Paving Co., The rcade, Cleveland, awarded contract for grading, rbing and paving 19,310 sq. yds. on 8 streets, sph., at $102,877.

Ore., Astoria—McLean & Williams, Astoria, warded contract by Clatsop Co. Court for paving ne mile market road and 5 miles main Neha'em wy., at total of $136,603.

Ore., Portland—Guy F. Atkinson, Port'and, warded contract for 24 miles constr. work on ugene-Florence rd. thru the Siuslaw national forst of Oregon, at $366,835. Proj. will include learing, grading, crushed rock and gravel surfacng; also bridge constr.

Ore., Salem—Hetrick, Cline & Gardner Port'and, warded contract by State Hwy. Comn., for impvt. f Otter Rock-Agate Beach section of Roosevelt oast hwy., at $181,000.

Tenn., Dyersburg—Rhodes & E'er, Nashville, warded contract for impvt. of 7 asphalt streets. Work starts June 1.

Tex., Corsicana—F. P. McElwrath, Corsicana, warded contract for 7.71 miles 9-ft. conc. pavement on S. H. thru Richland Creek Bottom, at 85,997.

Tex., Liberty—Houston Construction Co., 3102 McKinney Ave., awarded contract to pave 25 miles oad at $215,000.

Wash., Olympia—C. W. Payne, Spokane, awarded contract for grading, draining and paving with oncrete about 4.85 miles Sunset Hwy.—Spokane o. line to Reardan in Spokane and Lincoln Cos., t $161,503.

Wash., Olympia—Following contracts let by State Hwy. Cmn.: Inland Empire Hwy., Garfield Co., Pomeroy West, 1.43 miles to Pacific Coast Paving o., 910 Rust Bldg., Tacoma, Wash., at $8,802; Pacific Hwy., Lewis & Cowlitz Cos., 4.42 miles, Neals to Toledo, at $141,278 to Goetz & Brennan, 17 Seaboard Bldg., Seattle; Inland Empire Hwy., Stevens Co., 6.90 miles at $43,963 to Mitchell Bros., 127 E. Mission Ave., Spokane, Wash.; Sunset Hwy. Douglas Co., 3.07 miles, at $99,475, to Yakima Paving Co., 322 Perkins Bldg., Tacoma, Wash.

W. Va., So. Charleston—(Charleston P. O.) Dave French, Concrete Highway Constr. Co., Catlettsburg, Ky., awarded contr. for paving and sewer constr. (asph. or conc.) at $200,000.

W. Va., Logan—P. Minotti, Logan, awarded contract for paving 3.4 miles of road from Monitor Jct. to Holden, 7-in. conc., at $116,316.

W. Va., Welch—Danville Contg. Co., Danville, awarded contract for grading 7.4 miles rd. from Bradshaw to Grundy, Dandy River Dist., at $65,825; hard surfacing 14½ mi. rd. from Thorp to Jenkinjones and Keanette to Leckie, Adkins Dist. to Valdwin & Jennings, Gary, at $340,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Long Beach—Griffith Co. L. A. Ry. Bldg. L. A., awarded contract at $105,000 for constr. of Linden Ave. storm drain sewer and extension (rein. conc. pipe 12-in. to 42-in. diam.); Peter P. Janich, 1395 St. Louis St., Long Beach, awarded contract for constr. of 14-in. rein. conc. drainage sewer in Bennett Ave., Ximeno Ave., and alleys (Quincy storm drain extension), at $1,995.

Cal., Los Angeles—Croatian-American Inv. Co., Inc., 208 W. 2nd St., awarded contract for constr. of sewer complete in Burch Pl.—Country Club Dr. to 12th St.,—at $57,700.

Cal., Pasadena—Joe. Chutuk, awarded contract for constr. of segment block sewer at sewage disp. plant at City farm at $43,007.

Cal., Riverside—H. D. Churchill Co., 350 Merrick St., Los Angeles, awarded contract for constr. of san. sewer system, wye branches, manholes, cleanouts, boxes, sludge basins, piling and conc. syphons in various streets, at $117,348.

Cal., Whittier—Harvey Hanawalt, La Verne, awarded contract for constructing lower end outfall sewer and disposal wk., including Imhoff tanks and sludge beds. This omits filter. Contr. price $48,000.

Que., Montreal—Contract for sewer in Patricia and Tiffin Sts. to A. Thezand, 885 St. Catherine St. East, at $11,582 and $1,012 respectively; Decarie Blvd., Fallon and Boyce Sts. to Toussaint Bros., 383 St. I. Denis St. at $2,463; $2,123 and $1,457, respte.; St. Zotique St. to P. DeSantis. 3929 St. Hubert St., at $4,521; Eadie St. to C. Frascarelli & Co. 654 Berri St., at $18,177.

N. B., St. George—Stephen Constr. Co., Prince William St., St. John, awarded general contract for extension to sewers, at $36,000.

Ind., So. Bend—G. F. Santry Co. 809 S. Leavitt St. Chicago, award. contract for 5,986 ft. 6-12 in. vit. clay sewer, etc. in Clyde, Kinyon, Anderson, Medora, Lafayette and Marietta Sts. Indiana and Parkovash Aves., at $12,456. Engrs'. Est. $14,629; Staples & Ackerman, 424 W. Madison St., 7,789 ft. 6-15 in. vit. clay sewers in Fairview, Calvert and Victoria Sts. and Oak Park Court at $15,927. Engrs'. Est. $18,398; G. McGillicuddy, Valparaiso, 4,995 ft. 6-18 in. vit. clay in Brookfield and William Sts., at $12,241. Engrs'. Est. $12,471.

Ky., Louisville—Cannel-Conrad Constr. Co. Brook St. and Avery Ave. for 34th Street sewer and laterals at $120,334 and $47,203, respectively.

Ky., Paducah—E. R. Harding Co., 400 Robinson Bldg., Racine, awarded contract for 14,833 ft. 6-42 inch rein. conc. and vit. clay sewers, at $2,861.

Md., Baltimore—Ryan Constr. Co., 735 Real Est. Tr. Bldg., Phila., awarded contract for storm water constr. 57, at $107,003.

Mass, Boston—Wm. Barrett & Co., awarded contract for sewerage works in Bedford St., at $8,811; C. & R. Constr. Co., awarded contract for sewerage works in Farragut rd. extension and outlet in private land, So. Boston, at $37,935; Jno. Williams & Co., awarded contract for sewerage works in Stowe Rd., at $7,933; R. Zoppo, contract for sewerage works in Dana Ave., at $4,243.

Mass., Boston—V. Barletta, awarded contract for bldg. Dorchester brook sewer in E. Cottage St. and Humphreys St., from Norfolk Ave. to Holden St., Dorchester, at $58,033; M. DeSisto Co., awarded contract for sewerage works in Prospect St., etc., at $5,417; C. Russo, contract for sewerage works

in Ashland St.—Hyde Park Ave. to so. side of Sutton St. W. Roxbury, at $11,075.

Mass., Framingham—R. H. Newell, Uxbridge, awarded contract for 7 mi. 6, 8 and 10-in. sewer pipe in Framingham and 5 mi. Saxonville (Framingham, P. O.) at $115,960.

Neb., Humboldt—Asplund Constr. Co., Tecumseh, awarded contract for sewer system, at $28,551.

Neb., Milford—Arthur Dobson Co., 809 1st National Bank Bldg., Lincoln, awarded contract for san. sewer system at $30,685.

N. J., Glen Rock—(Ridgewood, P. O.)—Sewerage system, 3 sects. to E. B. Edgar, Scotia, N. Y., and 1 sect. to Alberto & Co., 208 Hamburgh Ave., Paterson; sewage disposal plant and pumping sta. to M. Averill, 196 Woodside Ave., Newark—total cost approx. $290,000.

N. J., Matawan—Seaman & Letzkus Co., Stone Harbor, awarded contract for 6.5 miles 6-12 in. sewers, at $84,423; sewage disposal works at $16,998.

N. Y., Buffalo—F. L. Cohen, Inc., Prudential Bldg., awarded contr. for 33 ft. 6-in. by 32 ft. 6-in. rein. conc storm water drain at Scajaquada Creek at $1,379,233.

N. Y. Long Island City—M. E. Connolly, Pres. Queens Boro. Queens Subway Bldg., let contract for sewer in Goodrich St., to Green Contg. Co., 734 Vernon Ave., Brooklyn, at $9,869; 77th, 101st, 78th, 89th and 130th Sts., to E. J. Kelly, Jr., Flushing, at $22,852; to D. Bonnacci, 672 Degraw St. Brooklyn; sewers in Bliss St. $8,194, 95th St., $6,101, 95th Ave., $22,853, 84th St., $29,369; Seaside Contracting Co., 193 Beach 108th St. Rockaway Beach, Kimball Ave., at $9,663; J. Gallo, 203 Division St. Brooklyn, awarded contract for sewer in Mitchell Ave. Lawson, Millard & Norwood Sts., etc., at $63,022.

N. C., Fayetteville—Tucker & Laxton, Realty Bldg., Charlotte, awarded contract for sewerage system, at $150,000.

N. C., Marshville—J. B. McCrary Co. 3rd Natl. Bank Bldg. Atlanta, Ga., awarded contract for sewerage and water works systems here, at $75,000.

Ohio, Akron—Schroeder & Caputo Constr. Co., 1950 W. Federal St., Youngstown, contr. for 8-20 in. vit. sewer, at $6,364; S. Main & Emeling Sts., 30-in. brk., $25,158; S. Arlington St. Dist. Cont. 5, 3-in. and 36 in. brk. pipe, $46,018; S. Arlington St. Dist. Cont. 3, 8-in. 12-in. 15-in. 18-in. 24-in. all vit. pipe, $25,000. H. T. French Constr. Co., 688 Noah Ave. W. Market St. outlet sewer, 30-in. 54-in., 63-in. open cut, $25,450 ft. 63-in. in tunnel; all foregoing brk. pipe—total $135,905.

Ohio, Cleveland—Contr. for 1,430 ft. 24-in. vit. tile sewer in Melba Ave. to. G. Derwish, Cleveland, at $4,498; 320 ft. 3 C and 320 ft. 2 C brk. sewers in Prince Ave. to J. Lahnom, 1133 E. 71st St. at $26,228; 17,613 ft. 18-30 in. vit. clay sewer in Ridge Rd. Impvt. 9, Sec. A, to D. Zullo, 10614 Frank Ave., at $233,272.

Ohio, Cleveland—Salem & George, 3645 E. 140th St. awarded contr. for 6,125 ft. 12-20 in. vit. clay sewers in E. 117th St., E. 143rd, E. 146th and E. 147th Sts., at $43,349.

Garfield Heights—(Cleveland, P. O.)—A. Lanese Co., Columbia Bldg., Cleveland, awarded contract for vit. clay and c. i. sewers and water mains in E. 139th St. Neltrove, Alvin and Rexwood Aves., at $33,349; Saybrook Ave., E. 126th and 139th Sts. to D. Rossi & Marcelleti Co., 13701 Benwood Ave., at $12,205.

Ohio, Youngstown—Contract for Mahoning Co. vit. and concrete sewerage system in Boardman Dist. Sec. 1, awarded to Turner Contg. Co. Park Theater Bldg., at $28,699; Sec. 2 to Turner Constr. Co., 242 Madison Ave., N. Y. City, at $52,108; Sec. 3, to F. George, 657 Mahoning Ave., at $83,151; Sec. 4, to Grubb & Andrews, Youngstown, at $48,210.

Pa., Pottstown—D. H. Whitmer, Hagerstown, Md., awarded contract for laying 53,050 ft. 4-18 in. vit. sewer pipe, 5 tons c. i. pipe, etc., at $86,409.

Tex., Denton—W. M. Jagoe, awarded contract to construct sewage disposal plant, at $40,000.

Tex., Navasota—Smith Bros., Inc., 311 Central State Bank Bldg., Dallas, awarded contract to construct storm sewer; Lock Joint Pipe Co., Dallas, Tex. contract for pipe at $31,540.

Wyo., Laramie—D. S. Reid, Denver, Colo., awarded contract for outfall sewers and sewage disp. plant on basis of alternate outfall and 27-in. lock joint pipe on outfall, at $117,094.

WATER SUPPLY AND PURIFICATION

Cal., Burbank—Claude Fisher, 610 Wright & Callender Bldg., Los Angeles, awarded contract for furnishing and laying 9,000 ft. 6-in. stand. screw wrought iron water pipe on Magnolia Ave. at $1.44 ft. and 2,500 ft. 4-in. same type pipe, at 84c ft.

Cal., Los Angeles—Sidney Smith, 2025 Bay St. awarded contract for constructing water distributing system for Dilling & Lichty in their Florence Ave. Heights Tr. Hyde Park, involving 2,000 ft. 6-in. screw casing at $1.25 ft.; 2,500 ft. 4-in. at 77½c ft.; 5,000 ft. 2½-in. pipe dipped at 42c ft.; 10,000 ft. 2-in. pipe dipped at 42c ft.; also fittings and valves at cost plus 20%; also contract with H. Middleton for furnishing and laying cast iron water mains with cement joints, Belle Meade Tr. involving 5,800 ft. 6-in. Cl B. bell & spigot pipe at $1.50 ft.; valves and fittings to be paid for extra; also contr. with Title Ins. & Trust Co., thru T. C. Shoults Co. for furnishing and constructing pipe lines for water sys. in New West Hollywood Tr., involving 1,000 ft. 4-in. pipe at 77½c; 5,125 ft. 3-in. pipe at 65c ft; 8,000 ft. 2-in. pipe at 40c ft., valves & fittings and labor for installing same at cost plus 20%.

Cal., Los Angeles—Sidney Smith, 2025 Bay St. awarded contracts for following work: Pipe lines Park for Snodgrass & Peters, all 3 tracts are in m Tr. 6115 for H. A. Greene, abt. $2,500; pipe fines for water sys. in Inter-Mountain Invest. Corp. tract, at $4,500; pipe lines in Washington

Cal., San Marino—Sidney Smith, 2025 Bay St. Los Angeles, award. contract by San Gabriel Valley Water Co., for trenching and laying 6,200 ft. cast iron pipe with cement joints at 55c ft.; and 3,500 ft. 4-in. cast iron pipe with cement joints at 35c ft. Pipe is to be laid in the Oak Knoll Dist., of San Marino.

Cal., Santa Ana—U. S. Cast Iron Pipe & Foundry Co., 705 Wright & Callender Bldg., Los Angeles, awarded contract for furnishing city with approx. 1,000 tons cast iron water pipe, at about $60,000.

Ont., No. York Twp.—Contracts awarded by Twp. Council for installation of new water works system are as follows: Dam, pump house, filtr. plant, R. Campbell & Co., at $39,230; pumping machinery, Bauden Machy. Co., at $12,117; filtration equipment, International Filtration Co., at $12,050; elevated steel tank, Morton Steel Co., $16,300; cast iron pipe, National Iron & Pipe Co., $19,000; tank foundations, Rocco & Co., $2,065; laying mains, Rocco Co. and Rusicco & Co., at $4,426.

Ct., Manchester—R. G. Bent Co., 183 Ann St., Hartford, awarded contract by Orford Soap Co., Hilliard St. for rein. conc. reservoir, 200,000 gal. capy., Engr's. estimate $60,000.

La., Plaquemine—City let following contracts for installation of water and light plant: Fairbanks-Morse & Co., New Orleans, at $78,545 for all machinery in power plant; Hayden Constr. Co., Pass Christian, Miss., general contract at $12,000; National Cast Iron Pipe Co., Birmingham, Ala., c. i. pipe; Gray Artesian Well Co., Pensacola, Fla., at $4,000 for artesian well; Columbia Iron Wks., Chattanooga, Tenn., for hydrants and valves.

Minn., Winsted—Phelps-Drake Co., 719 Metropolitan Bldg., Minneapolis, awarded contract for water works system at abt. $30,000.

N. Y., New York—Wataga Contg. Co., awarded contract for hauling and setting valves and hydrants in various streets, at $39,000; mains in Broadway, Amsterdam, 10th and 11th Aves., W. 51st St., 54th, 57th Sts., etc. to Beaver Eng. Co., 57 Chambers St., at $94,410; contract for furnishing, delivering, unloading, stacking and storing cast iron pipe, special and valve box castings, valves and double nozzle fire hydrants, to Kennedy Valve Mfg. Co., 95 John St., at $34,390; Norton Eng. Co., 510 W. 149th St., awarded contract for mains in Webster Ave., Bronx Boro., at $42,000.

Minn., Worthington—J. G. Robertson, 2542 University Ave. St. Paul, awarded contract for 1 water tube boiler and underfeed stoker. 300 h. p., at $23,375.

N. C., Mooresville—City let following contracts for constr. of water system costing approx. $155,000: Quion and Withers, Gastonia, pumpg. sta., filter house, auxiliary station, coagulating basin, storage reservoir, exterior piping, installing pumping equipment and laying pipe lines; Tucker & Laxton, Charlotte, filter equipment; Glamorgan Pipe & Foundry Co., Lynchburg, Va., furnish c. i. pipe; Morris Mach. Wks., centrif. pumps; Chicago Bridge & Iron Wks., Chicago, wash water tanks; Grinnell Co., Charlotte, Columbian valves; City will construct necessary elec. line for pumping purposes.

Ohio, Cleveland—Schirmer O'Hara Co., 2031 Euclid Ave., awarded contract for superstruct. of pumping station, 1 sty., 180x193 ft., 67 ft. high brick, steel and conc., at $516,568.

Ohio, Euclid—A. Harra Co., Ulmer Bldg. Cleveland, O., awarded contr. for mains in Emerson, Prasse, Telhurst and Rainbow Rds., at $16,952; Liberty Rd. to Joseph & Co., 877 Orange Ave. Cleveland, at $10,255; Liberty Rd. to Consolo & Palermo Constr. Co. Benwood Ave., Cleveland, at $12,827. Work includes 9,757 ft. 4, 6 and 8 inch cast iron pipe.

Ohio, Toronto—J. W. McLaughlin, Park Bldg., Pittsburgh, Pa., and Roberts Filter Mfg. Co., 6th & Columbia Sts., Darby, Pa., awarded contract for filtration plant and water works, at $142,100.

Va., Richmond—City let following contracts for constr. of City's filtr. plant: Contr. No. 1 to Whiting-Turner Constr. Co., Stewart Bldg., Baltimore, Md., for filter plant sub-struct., at $337,415; Contr. No. 2, filter plant equipment to Roberts Filter Mfg. Co., Darby, Pa., at $193,650.

Wn., Longview—Long Bell Lumber Co. awarded contr. for san. sewer 45,000 c. y. excav., 29,000 lin. ft. 8-30 in. pipe to Bardsen & Co., Butte, Mont.; storm sewer, 26,000 c. y. excav., 39,000 lin. ft. 10-54 in. pipe to J. D. Hanley, 1316 Rodney St., Portland, Ore. Engineer's est. $150,000.

Wash., Longview—Long Bell Lumber Co. awarder contract for water system for town, involving 56,000 lin. ft. 6-24 in. cast iron mains; 13,000 c. y. excav. to J. Payne, Kelso; Engineer's est. $100,000.

Wis., Wauwatosa—G. E. Zimmerman, 3402 Grand Ave., Milwaukee awarded contract by Met. Sewerage Comn. for main sewer from end of Cont. 1 in State St. to county institutional bldgs., at $247,112.

Prospective Work

ROADS AND STREETS

Ark., Pine Bluff—Plum Bayou Road Impvt. Dist. A. E. Wright, Chmn. contemplates expending $200,000 for constr. of 20 mile gravel rd. in northern part of Jefferson Co. Elbert H. Reynolds, Engr.

Ark., Walnut Ridge—Three Street Impvt. Dists. have engaged engineers to submit plans and ests. of cost of paving streets. Districts Nos. 1 and 2 retained G. S. Buchanan, Morrillton and Dist. No. 3, Wm. B. Hodgens, Walnut Ridge, as engineers.

Fla., Inverness—Citrus Co. Commrs. plan to complete State Rd. 5 together with lat. rds. thru County. $750,000 bonds voted.

Fla., Jacksonville—$2,350,000 bonds voted by Duval County for bldg. 6 roads; $450,000 for construction of 2 bridges.

Fla., Punta Gorda—State Road Dept.,—H. B. Phillips, Chrmn., Tallahassee—plans to complete section of Punta Gorda-Fort Myers road and appropriated $75,000; Charlotte Co. to receive $50,000.

Fla., Tallahassee—State Rd. Dept.—H. B. Phillips, Chrmn.—Plans improving 6 roads and appropriated funds as follows: Lee Co., St. Rd. 5, $25,000; Charlotte Co. rd., $50,000; surf. S. A. Rd. 107, shell or rock, DeSoto Co., $25,000; Hanatee Co., $25,000; rds. in Glades Co., $40,000; Franklin Co., improve S. A. Rd. 116, $50,000; County to pay $50,000. Also plans expending $1,250,000 to build east coast hwy. thru Flagler and St. Johns Cos.

Ind., Indianapolis—Approx. 19 miles of a 50-mile program of bitum. macadam paving will be constructed this year by St. Hwy. Dept. Mileage will be let in 7 proj. awards. Five counties affected. First bitum. macadam will be laid in Wells, Wayne, Allen, Lawrence and Monroe Cos. Roads are as follows: Rd. 13, Wells Co., extending from brk. pavement in Ossian, south 5.96 miles. Date set for completion, Nov. 15; No. 3, Wayne Co., extending over certain parts from west corp. line of Richmond west to east end of conc road, 1.07 miles. Completion date, Nov. 15; No. 3, Wayne Co. from each corp. line of Richmond, west to Indiana-Ohio State line, 2.97 mi. Completion date, Nov. 15; 14, Allen Co., from so. corp line of Ft. Wayne south 3.47 miles. Comp. date, Nov. 10; No. 44, Allen Co., from west line Ft. Wayne, west 0.80 miles. Comp. date, Nov. 10; No. 22, Lawrence Co., from no. corp. line of Oolitic to Village of Needmore, 2.1 miles; comp. date, Oct. 15; No. 32, Monroe Co., from jct. with State rd. 22 at north corp. line of Bloomington in northwest direction 2.25 miles. Comp. date, Oct. 15. State Hwy. Comn. Jno. D. Williams, director.

Ia. Muscatine—About $125,000 will be expended on paving here during 1923. G. G. Parks, City Clk.

Ky., Calhoun—McLean Co. plans to improve 8 roads, totaling 70 miles; awards contingent upon $350,000 bond issue to be voted on August 4.

Md., Baltimore—Board of Estimates considering plans presented by A. E. Christhilf, Chf. Engr., to cover Gwynn's Run from Baltimore St. to Sequoia Ave. Est. cost $1,000,000. First step to cover stream from Baltimore St. to Penn. R. R. above Lexington St. Approximate cost $100,000.

Mich., Flint—City Council has approved program providing for paving 22 streets and sanitary sewers on 14 streets. Engineer also given authority to proceed with construction of 12 storm sewers. Council has authorized purchase of 2 tractors to be furnished in accord. with specfs. by City Engr.

Mich., Romeo—Citizens have voted to authorize bond issue of $75,000 for paving east and west St. Clair Sts. here.

Minn., St. Paul—City and County officials have decided on following paving for 1923: City Paving: Minnehaha St., $143,000; Lake Phalen Blvd., $120,400; Larpenteur, $6,000; Snelling, $53,400; Connec. thru Como Park, $38,000; River Blvd., $350,000; W. 7th, $90,000; Randolph, $140,000; Sixth, $203,000; Larpenteur, $80,000; Cleveland, $143,000; Robie and Humboldt, $132,000; Sibley Memorial Hwy., $42,000; City Hosp. approach, $21,000; Rondo, $40,000; Oakland Cemetery approach, taoinngs,oSo ant. $108,000; Front, $198,000; Earl, $200,000. County: White Bear Ave., 5.9 miles, $178,000 Edgerton, 1 mi. $30,000; N. St. Paul Rd., 2.5 mi. $75,000; Rice St., $153,000; Co. Rd., 6.7 miles, $102,000; Prescott connect. 4 miles, $180,000; New Brighton rd. 2.5 miles, $75,000; Eustice St. ½ mile, $15,000; Cleveland Ave., ½ mi., $15,000. County's 1924 program is as follows: Centerville Rd.—Edgerton to Centerville and SW exten. to Rice St. rd. 10.8 miles, $326,600; Birch Lake Ave. —Bald Eagle Ave. W. along no. side Birch Lake to Centerville rd. and Bald lake to Centerville rd. and Bald Eagle Ave. from Trunk Hwy. 1 NE to Dellwood, 6.5 miles, $225,000. Geo. J. Ries, Co. Aud.

Mont., Hardin—$105,000 is estimated cost of hard surf. rd. to be built bet. Hardin and Custer (17½ miles). Will get Fed. aid. R. J. Ehpland, Co. Engr.; Carl Rankin, Co. Aud.

Neb., Plainview—Antelope Trail will be surfaced this spring from Plainview to Orchard via Brunswick. Govt. and State aid. S. Greenmayer, Brunswick, interested.

Nev., Carson City—State Hwy. Dept., (Geo. W. Borden, St. Hwy. Engr.) will soon call for bids on 3 important projects in Elko Co., plans now being complete. Projects are Halleck to Deeth; Deeth to Wells and Vivian to W. County line—total about 40 miles.

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EDITORIALS

WHY THE CANALS WERE DISCARDED

Upwards of a hundred years ago the development of inland waterways in the Middle West had reached a point that is surprising to one who goes over the old records. Canal building was as much discussed, and at least as well understood, by the general public at that time as highway improvement is today. The people knew what the canals were for, why they were built, and they knew also that these waterways were built with public funds.

It is not the purpose of the present discussion to give figures pertaining to the extent and usefulness of canals long since discarded; that may be done at another time.

The object of this discussion is to point out the fact that when the privately owned railroads rendered better service than the publicly owned canals the public very quickly "junked" their own investment.

Now, a hundred years later, if the publicly owned highways render better service than the privately owned short rail lines, can the public be blamed for turning from the rails to the highways? Are obsolescent utilities to be scrapped again? If so, or if not, how much weight should be assigned to the fact that this time the obsolescent utilities are privately owned, whereas on the other occasion they were publicly owned? If private ownership is a bar in the path of progress, isn't that a pretty good argument against private ownership?

THE GOOD ROAD

A good road, in the strictly modern sense, is one over which all legitimate classes of modern highway traffic can run rapidly, without interruption, and in safety, in any kind of weather, in any season of the year, and at any hour of the day or night.

Many roads are called good, by the motorist, if they are good part of the time and under certain favorable conditions. These same roads at other times may be very far from satisfactory. A road that is excellent today and bad a week from now is not a good road.

In the public mind the "good" road is often taken to include any road which is not hopelessly bad, or any road that is somewhat improved, or a road that under some circumstances is quite satisfactory. With standards rising higher all the time it is well to emphasize that a road is not worthy of the name "good" unless it functions properly at all times. The difference in first cost between such a road and one that is satisfactory only part of the time is not great, especially when maintenance costs are considered, for it is a well-known fact that the cost of maintaining a fair road is much greater than the cost of maintaining a good one.

ROAD SURFACES AND TIRES

Interesting statistics have been quoted from time to time showing clearly that, as one would naturally suppose, the mileage secured from automobile tires on the higher types of road surfaces is substantially greater than on the lower types. This fact, together with a corresponding saving in motor fuel, is one of the best economic justifications for improved roads.

There is another aspect of this subject which merits more attention than it has received, and that is the protection the motor vehicle operator secures against punctured tires when he is driving over a thoroughly modern road as compared with a road of gravel, for example. It would be interesting to know how many accidents are due to blowouts and punctures on cars travelling at high speed on country roads of inferior types. Probably many more accidents are due to sudden tire failures than is generally appreciated. Almost any car becomes unmanageable if a tire fails at high speed; under such circumstances the driver becomes almost as helpless as if the steering gear of his car failed to work properly. He may run into other cars or into the ditch

and may suffer any degree of disaster due to a bad puncture which deflates a tire as rapidly as a blowout.

It is seldom indeed that tires are punctured on hard surfaced roads. These surfaces are clean; they are washed clean by the rain and blown clean by the winds and the air currents induced by traffic. As a rule anything lying on the surface of such a road is easily visible and is easily avoidable. In the lower type roads, nails, bolts, glass, etc., that may cause bad punctures are not only often held by the road material in such position as to puncture tires, but are not easily seen and avoided, as they blend indistinguishably w ith the color and substance of the road surface.

A motorist can start out on good roads with new tires and feel secure against tire trouble, but the same tires may be punctured in the first hundred feet he travels over low type roads.

The insurance against bad and dangerous punctures of tires afforded by really good roads is one of the greatest advantages of such roads.

DOCTORS, LAWYERS AND ENGINEERS

A writer in this issue develops an interesting viewpoint with reference to the comparisons so often drawn, by engineers, between doctors and lawyers on the one hand and engineers on the other. We do not wish to take the edge from his remarks by giving them here in substance; the reader will naturally prefer to read the article entitled: "The Engineer as a Professional Man."

Such comparisons have led to much loose thinking and have delayed the engineer some years in his pilgrimage to the promised land. The conditions of employment surrounding doctors and lawyers are much like those under which the consulting engineer works, but are quite unlike those with which salaried engineers are confronted. One reason why discussions concerning the status of the engineer have been so unfruitful to date is that many arguments made to fit the man who is "called in" for a "fee" are applied to the salaried man on a steady job, and they just naturally do not apply to him at all.

One wonders if the word "professional" is not about as badly overworked as the word "engineer." Nowadays almost everybody who does anything styles himself an "engineer" of one sort or another, and so great has become the misuse of the word that it means one thing to one man and something else to another. In a similar way many classes are using the term "profession" as if it were identical with "vocation." Not long ago we saw a reference to "the overcrowded profession" and supposed, of course, it meant engineering, but not so. Reading on, the fact was disclosed that the particular overcrowded profession under discussion was manicuring. The barber is rated by some as an unskilled laborer, but he regards himself as a professional man and, when feeling right and properly encouraged, can make out a pretty good case for his rating of himself.

Time was when the contractor was just a contractor, and that was glory enough, but now he, too, is putting on airs and styling himself a professional man. Formerly, also, one spoke of professional men *and* business men. Now many men regard business as a profession and speak of the profession of business. They, too, can make out a good case for their usage of words.

So, what with one thing and another, confusion is becoming worse confounded. Perhaps the engineer might do worse than discard the professional title along with a lot of traditional professional notions, of the virulent ingrowing variety, and style himself just a business man and act accordingly. He would be of as much service to society, as he is now, and perhaps more to himself. The thought is not wholly unattractive.

INDEX TO VOL. LXIV

The index to Vol. LXIV of this magazine, for the months of January to June, 1923, inclusive, is now being prepared and will be ready for distribution by the end of July. A copy of this index will be sent free to anyone who requests it.

Many requests for this new index have been received to date and it is a pleasure to note that such requests increase in number every six months. Many subscribers have learned that it pays to preserve their copies of this magazine for while it is not thick it can not be said to lack depth.

The cost of binding six, or even twelve, copies together is small and the volume is not of such great bulk as to be a burden even to the man who moves occasionally.

PAYING FOR CONSTRUCTION AND MAINTENANCE OF CAR TRACK PAVING

(Editor's Note: A conference on the "Design and Construction of Streets for Street Railway Traffic" was held under the auspices of the Engineers' Club of Philadelphia in collaboration with other engineering societies and the following discussions at the conference are here reproduced as reported in "Engineers and Engineering.")

The first authority quoted is Mr. Geo. W. Tillson, Consulting Engineer, La Grange, Ill. His remarks follow:

There is no question that the presence of street car tracks, in a public street, are a nuisance. It is, however, recognized that they are necessary. If tracks and pavements between and adjacent thereto were always kept in good repair, it would be different. But owing to financial, as well as other conditions, this is not true; in fact, it is safe to say that until recent years the pavement in the railroad area in the cities of this country was in a deplorable condition. As the tracks are generally owned and operated by private corporations, the city's engineers have no direct way of having repairs attended to promptly. Franchises generally provide a method by which municipalities can have repairs made legally; the process, however, involves much red tape and loss of time.

It seems to be generally admitted that the railway company should make all repairs to the tracks, but, during the last few years, much discussion has taken place as to whether the company should lay and maintain the pavement in the track area. As a matter of fact, this obligation has been imposed upon nearly all street railways in the past. The question of this obligation being continued is not a simple one; rather it is quite complex. The pavement must be taken care of and the cost of the same paid for by the general public or two certain parts of the public.

If it is paid for by the railway company it becomes a part of first cost, and this, together with maintenance, must be provided for in the amount to be charged for each ride, and so will be paid by the riders. It is true that except within the last few years 5 cents has seemed to be the proper fare for a street car company to charge without regard to cost of road or size of the community in which the company is operating. Why this is so, no one knows. But when it is proposed that fares should be raised a great outcry goes up as if a 5-cent fare were sacred.

If, on the other hand, all paving work is paid for by the abutting property and the railway company does not pay any of its cost, it will all be charged to the abuttors.

The ordinary double track road practically uses 15 ft. of the most valuable part of the roadway and at times during the rush hours fills the street to such an extent that vehicular and even pedestrian traffic is very much impeded. Is it right, then, that the abutting property should pay for the pavement when its space is actually used by the railway company?

If neither the railway company nor the abuttors pay the cost, it must be provided by the city at large and the money raised in the tax budget.

It may be said, in answer to the argument that the cars in rush hours impede traffic and consequently damage property, that the existence of car tracks on a street enhances, rather than diminishes, property values on such a street. This may be so in an outlying district where there is no congestion, where the property is residential and where the owners wish to reach down-town sections quickly. But, for instance, take the loop district of Chicago, where practically every street has a double line of car tracks; can anyone question that if half of the street were free from tracks that the property on those streets would not be more valuable than on the car track streets? In a residential section the car track streets generally have a line of small merchants doing business on the street to supply local wants and so make some property more valuable, but the better residences will always be found upon the streets that are without tracks—and in almost every instance the residents of a well-built-up street will resist the construction of tracks on that street. It seems to the writer that in no case should the abutting property on a street be put to any extra expense on account of the existence of a car track. If anything, the amount of paving to be paid for should be less, as it is a well-known fact that the cost per yard for any pavement on a car track street is considerably more than on a street where there is no track. This is also true as to maintenance. During the years of 1913 to 1918, inclu-

sive, the cost of repairs to asphalt pavements in Brooklyn, N. Y., on street car track streets averaged $0.039, while on streets without tracks it was $0.022. This was on an amount of over 40,000,000 sq. yds. of pavement. Admitting, for the sake of the argument, that the abutting property owners are not to pay for the track pavement, there remains to be considered the general public and the car-riding public. These two parties must be considered together to a certain extent.

It is generally admitted that as a street car company operates in a public thoroughfare, where it has no inherent rights, that it must pay something for the privilege of operating. This is irrespective of payment for an inconvenience to, or interference with the general public. This right or privilege is generally called a franchise, and is given by some legally designated body. Coupled with this franchise are certain conditions with which the company must comply. The principal ones generally relate to pavements, snow removal and sometimes to special amounts to be paid for each car operated—and the rate of fare.

Previous to 1907, the Philadelphia Rapid Transit Company was required to pave from curb to curb all streets upon which their cars were operated. In that year, however, a contract was entered into between the city and the company by which the latter was to pay a lump sum of $500,000 annually. This relieved the company from all costs of paving, snow removal and other minor obligations. The contract also provided for a certain annual increase in the amount to be paid. The writer is told that the total amount now is about $550,000.

A street car company is organized and operated for profit. Whatever its expenses may be, whether of construction, maintenance or operation, they must be paid for by the people who ride, and the more stringent the conditions, and the more rigid the requirements, the more the company must earn to pay a reasonable dividend to its stockholders and the rate of fare must be adjusted to this, unless it be accepted as a fact that a 5-cent fare is proper for all street car companies without regard to any conditions whatever.

It may be said that such a discussion as this is purely academic, and not practical, as all companies interested now have franchises, and that in the next twenty years comparatively few new companies will be organized. This is undoubtedly true. But if franchise conditions are to be modified, the principles above laid down are pertinent.

Admitting that the company must pay for its franchise, the exact amount to be determined by general conditions, to be revised at certain intervals, if necessary, the principal conditions to be determined are: Amount of paving to be laid and maintained, if any; what shall be done about snow removal, very important in northern cities; and rate of fare. The amount to be paid to the city for any purpose affects the general public as well as the riders. It should not affect the stockholders, as they should be taken care of by the fare charged.

It may be said also that in the existing franchises the rate of fare has already been fixed. This is true, too, but if it be admitted that any condition of a franchise may be changed, all may, and consequently the rate of fare.

The last few years have pretty clearly demonstrated that it is impossible to fix all the conditions of a franchise that extends over a long term of years so that they will always be just to all parties, and when changes are necessary, they should be made in a fair and equitable way.

But, to get back to the question of franchise conditions, it does seem that any company seeking the right to operate a street railway in a public street or road should pay for that right, either as a lump sum or as an annual rental; also for what it costs to keep the streets in good condition in the portion it occupies at all seasons of the year. This last, it seems to the writer, means the construction and maintenance of the pavement in and between its tracks, and such a distance outside the rails as may be disturbed in repairing or laying new tracks; also removing the snow from the same area. These points must all be given careful consideration when the rate of fare is to be fixed.

As has been heretofore intimated, the writer does not believe that the franchise conditions should be irrevocably decided upon, but that provision should be made for their revision at certain intervals by a public service commission, or some similar body, or where none exists, by a court that has suitable jurisdiction.

As an academic proposition, are the above conditions too harsh to be imposed upon any railway corporation seeking a franchise? Should the general public be

charged for any of them? Should they not be paid for by the riding public that uses the cars? If the rate of fare be properly adjusted, it makes no difference to the company or to its stockholders. If the above line of argument be agreed to, it follows, of course, that the riding public, and not the general public, should pay for the cost of pavement construction and maintenance.

Coming now to the proposition of what should be done with existing railway corporations who question whether they ought, or ought not, to be required to lay and maintain the pavement in the railroad area, it seems to the writer that the principles herein laid down will hold good. Many franchises for street railway companies have been given in perpetuity for no cash payment, but requiring the companies to keep the pavement in repair, and providing for a rate of fare. If neither of these conditions can be changed, there is no use in arguing the question, and if one can, either or both can. Assuming this to be possible, why should not the fare be changed if cost of materials, labor and everything that enters into maintenance and operating expense has increased from 50 per cent to 75 per cent or perhaps more? The rates on steam railroads have advanced approximately 80 per cent. The wages and salaries of those who ride in the street cars have been raised to keep up with the new cost of living and if prices for any one activity remains the same, it is practically a reduction in cost to the users thereof.

The original contract of the New York subway was immensely profitable, but when the great system was established the first contract was merged in a new one with the consent of both parties. Many other contracts of various natures have been modified materially as a result of the changes brought about by the World War; it being recognized that these changes were so enormous, and such as could not be foreseen, that equity demanded a readjustment.

It will be urged that if it be proper to raise fares on account of unprecedented increases in costs, it would also be right to lower them when costs decrease. This is undoubtedly correct, and that is why the writer believes in a readjustment clause in any long-time franchise which is merely a contract under another name.

The writer believes that all investors in a deserving public utility should have a fair return for their money. Watered stocks, however, are different and should be treated differently. He believes further that, as a general proposition, where a needed public utility, operating under a long franchise, and in a business way can not pay dividends on account of the advanced costs of operating, it should be permitted to increase its rates for service rather than to decrease costs by modifying conditions.

Mr. J. A. Griffin, Chief Engineer of the Board of Public Works of Los Angeles, Calif., gave the following information on practice in his city:

The responsibilities of the street railway company as to cost of installation and maintenance of paving is practiced in our city along the following lines: The franchise or permit to use the street that is issued to the railway company contains a clause that they shall install and at all times maintain the same type of pavement on their right-of-way, which extends from 2 ft. outside the outside rail of one track to 2 ft. outside the outside rail of the other track, as is used on the balance of the street, unless special permission is granted to do otherwise. This method works out very well and practically no friction occurs between the street railway corporations and the city. In some instances where extensive paving programs have progressed very rapidly, the railway companies were unable to pave their portion at or near the same time the other portions of the street were paved, but in each such instance they altered the grades of their tracks and covered the dirt surface with screenings and oil to make their portion passable until such time as they could follow with permanent paving.

Mr. C. E. De Leuw, Consulting Engineer, Chicago, contributed the following to the discussion:

The present responsibility, in general, is to install and maintain all paving within the right-of-way of the companies. This obligation has arisen through the growth of the traction industry. In former days when horses were used to draw cars, the space between the rails, called the horse-path, was paved and kept in condition by the operators, in order to secure "good traction for their motive power." As traffic became heavier, the space between tracks was also paved by the companies in order to permit vehicles using the tracks to pass from one to the other track, in order to save time in pulling out ahead of street cars to per-

mit their passage. This step resulted in the entire right-of-way being paved at the companies' expense.

With the advent of electric traction, the need for paving was of much less import from the viewpoint of the companies—except to permit vehicles to cross tracks readily, to pull out ahead of cars, and thereby avoid delays.

During the period of the great development of electric traction there was neither regulation nor supervision on the part of the public; consequently, the surplus profits from operations were held entirely by the companies—profits which in many cases were large. The public, in attempting to reduce these profits where excessive, placed many burdens upon the operating companies, which tended to increase operating expenses, reduce dividends and to give some form of physical or service improvement to the public or to the car riders. These burdens were usually imposed as franchise obligations. This action usually resulted in an effective means of political control and utilized at times when the public demanded extensions to the property, or when franchises were under consideration for renewal.

With mounting operating expenses and rising fixed charges, due to the more costly investment in plant and in equipment, the necessity of fare increases, particularly during the war period, became a vital matter. From these facts there has arisen a decided swing towards "service-at-cost" franchises. This is the general tendency in electric traction circles today.

Any changes, which are not solely the result of creating transportation, which are assessed against the car rider, prevent his obtaining service at cost. Therefore, from the financial side alone, all charges, such as the maintenance of paving, sprinkling and sweeping the right-of-way, and the like, should be borne by the public rather than the car rider through payment of fares.

However, as track and paving are of intimate construction and design, and as the tracks can not be repaired without the removal of the paving, it is a difficult matter to draw a sharp line of demarkation in making a separation of the direct charges. Further, paving will be disintegrated should the rails be poorly secured to the ties or should the track foundation fail.

In consideration of the above remarks, it is suggested that a separation of track and paving be made, and that the burden of cost to the car rider be held to the lowest possible amount, as determined solely by the actual value he receives from his purchase of transportation. He should not be compelled to pay indirectly for the cost of anything which he does not and can not use.

If such a division were made and the charges and costs directly allocated, then "Service-at-cost" would be a verity.

THE ENGINEER AS A PROFESSIONAL MAN

(Editor's Note: The following discussion has its points. It was published as a letter to the editor of the Military Engineer for May-June, 1923. It was written by Charles H. Roe of Tarrytown, N. Y. Mr. Roe displays a real understanding of things as they are and he reports his findings in a virile style which should help engineers find out just where they fit into the scheme of things. What he says of doctors and lawyers is not what the average engineer writes when he holds these two old professional classes up as models for engineers to copy. Probably he intentionally overstates the unfitness of doctors and lawyers to serve as models for engineers; certain it is that the opposite view has been enlarged upon sufficiently. Since practically all doctors and the great majority of lawyers work for fees, while nearly all engineers are salaried men, comparison between these essentially dissimilar groups are worse than useless as they are misleading. Mr. Roe's advice to the engineer to get out of engineering if it doesn't reward him sufficiently, while good advice for the individual, is no solution at all in the broad sense affecting the profession as a whole, on the one hand and the public on the other. There will always be engineering work to do and it is the opinion of the editor of this magazine that it will be much better for the public, in the long run, if the men actually engaged in engineering are properly paid for their services. Mr. Roe's opinions are here reproduced as they undoubtedly are valuable, especially to the younger engineers, although it is not to be expected that all will agree with him.)

"We have read too much and heard too much to the effect that a man with technical training and ability will rise in his profession by sheer virtue of that training and ability, whereas that is far from

being true. I am convinced that promotion in modern industrial organizations, even tenure of position, in fact, does not depend upon ability, training, or experience, to nearly so great an extent as it does upon such irrelevant circumstances as family relationship; membership in church or lodge favored by superiors; inclination to be a 'good fellow,' meaning a penchant for petty gambling, boozing in a 'gentlemanly' manner, and telling funny stories one wouldn't repeat at a church social; and, finally, upon the existence or non-existence of a vacancy into which one can be placed.

"I dare say every reader can recall individual experiences in which young Mr. So-and-So was made superintendent of construction because his father was on the board of directors; or in which Mr. Thingumbob became very friendly with the 'Big Boss' as soon as the latter learned he belonged to the same lodge—net result, promotion for Mr. Thingumbob; or in which Mr. Whatsis was made head of his department because he was 'such a good mixer and all the boys liked him'; or in which Old Fuzzletop remained on his job for 17 years, a matter of great pride to himself, but effectually barring young Ambish from climbing into his shoes. All this is no indictment of any one or any circumstances; it is perfectly natural as long as human nature is human.

"The reason is obvious. Our superiors, those who 'hire' and 'fire' us as engineers, are mostly pawns of fate, despite their own opinions to the contrary. Perhaps only ten percent of them are in their positions because of merit and the other ninety percent are accidents of the types described above. What else, then, can be expected from men like that, then that they judge us by the same standards they were themselves judged by?

"My own solution of this problem is to start or acquire an industry of one's own. I assert most emphatically and believe positively that by virtue of his training the engineer will make a better business man, banker, chicken farmer, or garage keeper than any other type of man. Ergo, if an engineer meets misfortune or unpleasant experiences in other men's organizations, let him start an organization of his own. No one will deny that there are many more graduate engineers turned out of our colleges today than the country needs. If anyone wants to know where they go, he can obtain a little interesting information from the yearbooks published by the engieering societies or various publications of the colleges. 'John Jones, M. E., '08, vice-president Smith & Jones, fur Importers' may not be a representative entry but it is not an unusual one. So to the engineer dissatisfied with his lot as an employe, I quote the old army expression—'If you don't like this war, go and start a war of your own.'

"But I do not like the suggestion about an organization of engineers to promote their own material welfare. How many engineers can say they have a sincere, honest respect for the legal profession? How many of us believe that doctors of today are the self-effacing alleviators of suffering that the country practitioner of past generations was? Then why should we debase ourselves by patterning after them? The lawyer deals with very fallible, man-made criteria of justice. Too often he forgets the justice in the effort of applying the criteria. Also, how much sincerity can we expect to find among a profession the members of which, in practice, are always lined up in pairs, whereby one out of each pair must necessarily be wrong, yet he must simulate sincerity even if he does not feel it in declaring his side right? Doctors deal constantly with the physical results of human erring. They delve in loathsome filth. They know more of sin than a father confessor. There are many true noblemen among them, but they are very conspicuous. What wonder that the doctor often becomes more interested in the size of his fee than in the relief of suffering? The engineer handles the immutable laws of God as his working tools; he converses with the stars; he measures the cataract and bridges the chasm; he makes the desert bloom; he flings his voice into space and contrives means to transport men and materials with chained lightning; he measures the huge sun and a tiny electron and he discusses eternity and infinity with a famliiarity that would have sent him to the fiery stake a few centuries ago. It may be idealistic, it may not be practical, but I would rather see engineers as they are than bound into an organization to demand 'adequate' remuneration and to 'enforce' respect from others.

"I have heard a great deal about the low pay of engineers. I have also heard similar complaints from other professions. I can not state that engineers as a whole are paid well or otherwise, for I do not know—that is a matter the statisticians can easily .settle—but I have known en-

gineers earning very large salaries and I have known doctors who never acquired enough to own their own homes and lawyers who stooped to the most despicable practices to make a very modest living. It is a matter that no individual can judge of his own experience; let someone trot the figures out and see if engineers are underpaid.

"The state registration law? Yes, by all means, but let the engineer continue his way as he is, a student of nature, a builder, a dreamer of dreams, knowing that he is right even if the gold-grubbers sneer and say he is wrong; let him continue thus rather than to organize and demand increased pay, like a striking laborer, or insist upon respect like a shavetail insisting upon a salute."

HIGHWAY TRAFFIC INSPECTION FORCE AUTHORIZED IN PENNSYLVANIA

The Pennsylvania State Highway Department is laying plans for the inauguration of the traffic inspection force authorized by the legislature in the motor law recently signed by the Governor, as announced by Paul D. Wright, Secretary of Highways, in the following statement:

As soon as possible traffic officers will be placed on Pennsylvania highways. These men are provided for in the section of the Act of 1923 which amends Section 12 of the Act of 1919, governing motor traffic. This amendment authorizes the Secretary of Highways to employ such men as in his discretion are deemed necessary to the enforcement of the penal provisions of the motor laws. Inauguration of this force will not only result in greater safety to the users of highways, but will conserve the State's resources, because we shall put an end to truck overloading which has been the most active agent in road wear and destruction.

Our traffic officers will pay particular attention to these evils: The overloading of trucks; speed of motor vehicles—and particularly the speed of trucks, and the misuse of headlamps. No truck will be permitted to use Pennsylvania highways when it carries a load greater than that specified for the particular class in which it is registered. No truck will be permitted to travel faster than the rate specified for the class in which it is registered. Our traffic force will drive from the roads that five per cent of vehicle operators who through carelessness, ignorance, or intent, endanger the lives and property of pedestrians and the 95 per cent of drivers who obey the laws and rules of the road. Pennsylvania highways will be unhealthy places for intoxicated drivers. So-called speed-demons will be curbed. The traffic force will be looking for those drivers who roar through the State utterly regardless of the rights of the other fellow.

We shall end the glaring headlamp evil. Accidents at night occasioned by the use of illegal lamps are too frequent. At this time nearly 150 headlamp lenses and devices have the approval of the Department. A great many of them are obsolete and dangerous. We shall re-examine the entire number and disqualify those which do not meet modern qualifications. A stop will be put to the use of lamp bulbs greater in candlepower than those permitted for a particular lens. Motorists so careless and indifferent that they use improperly focused headlamps will be rounded up.

It has been impossible heretofore properly to regulate the use of Pennsylvania highways. The result is the existence of modern Dick Turpins who are as dangerous to road-users as were their ancient predecessors. Because of these outlaws the average man takes his life in his hands when he goes upon a journey—particularly upon Sundays and holidays. The legislature has given the Department of Highways authority to safeguard the roads and their users—and we propose doing it.

Pennsylvania's traffic inspection force is to be uniformed. Secretary Wright and Benjamin G. Eynon, Registrar of Motor Vehicles, have not yet decided upon the style or color of these uniforms. The force will be mounted upon motorcycles. Certain members engaged in enforcing the law relating to truck weights will use motor cars in which their road scales will be carried. The number of men in the new force has not been decided. The law did not fix a limit, saying merely that the Secretary of Highways may employ such men "as in his discretion are necessary."

Another section of the new motor laws which will result in money saving to the taxpayers is the clause giving the Department authority to regulate the weight of trucks and loads at certain seasons of the year. Secretary Wright and his Deputy, William H. Connell, prior to next winter will announce regulations which will govern trucks on stone roads or roads other than a durable type during those seasons of the year when the highways are affected by frost. This is an innovation in

Pennsylvania, but a number of other American states have been regulating truck loads for years. During the recent highway conference called by Governor Pinchot a New England highway commissioner told of a fleet of overloaded trucks which in passing over a road as the frost was leaving did damage totaling $100,000. Users of Pennsylvania highways during the spring months this year observed on macadam roads the damage done by trucks carrying too great loads.

It is believed the advance guard of Pennsylvania's traffic inspection force will be on the roads within a month.

SOME RECENT LARGE WATER WORKS PROJECTS

By Dabney H. Maury, Consulting Engineer, 1445 Monadnock Block, Chicago, Ill.

Within the last two or three years the cities of Denver, Norfolk and Tulsa have undertaken water works projects of more than usual magnitude and, in a general way, the principal features of these projects are here discussed.

Denver

In 1918 the city of Denver purchased the water works system of the Denver Union Water Company. It had been in litigation with this company or with its predecessors for nearly 40 years, and as a result of this litigation each party to the controversy had employed a large number of engineering experts, practically all of whom were men in the front rank of their profession and of most excellent reputation.

Shortly after the purchase of the water works system, the Board of Water Commissioners, to whom its operation and maintenance were entrusted, endeavored to secure a bond issue of $4,000,000 for much needed improvements. Largely as a result of opposition on the part of one of the local newspapers, the bond issue was defeated, and the city has several times since been on the verge of a serious water shortage.

In 1921 the Civic and Commercial Association of Denver, in its efforts to bring about a solution of Denver's water supply problem, appointed a committee of seven Denver engineers, with instructions to recommend to the Water Commissioners three engineers who should constitute an Engineering Board of Review and who should be charged with the duty of studying the large amount of available data relating to the water supply and of recommending to the City improvements required to meet present and future necessities.

As the result of the recommendations of this committee, the Board of Water Commissioners retained Colonel Herbert S. Crocker of Denver, Mr. Harry T. Cory of Los Angeles, and the writer, as a Board of Engineering Review. Colonel Crocker was promptly elected chairman of the board. In view of the fact that all of the engineers who had prior to this time been connected with Denver's water supply, had been retained by one party or the other to the litigation, the engineers composing the Board of Review were practically the first against whom no charge of partisanship, based on the manner of their employment, could be brought; and they were also the first who were charged with a general review of all available data, and with the preparation of a general and comprehensive plan for future development.

The bulk of Denver's water supply already comes from the South Platte River, and all future increases in the supply must be made by combining storage on the South Platte watershed with additional water taken from the Colorado River on the west side of the Continental Divide and brought through tunnels into the watershed of the South Platte.

Most of the 100 miles of existing conduits are of wood stave, of various ages and in various stages of decrepitude. The principal improvements contemplated are to be secured by the issue of about $7,300,000 worth of bonds.

To the south of the Platte Canyon filters lies the upper watershed of the South Platte. The possibilities for future development here are large, not only in the valley of the South Platte itself, whose flow can be very largely conserved, and its yield augmented, by storage in a great number of advantageous locations, but also because of the fact that if additional water can be secured from the Colorado River with the consent of the Colorado Commission, and brought across the Continental Divide through tunnels, that same water can be stored in reservoirs up the Canyon, and let down as desired. The power possibilities also, while for the present somewhat remote, and susceptible of only gradual development, are quite large, running up above 100,000 horsepower; the development of power being made possible by the construction of the same reservoirs which will be required

for the storage of the city's water supply.

The essential feature of our report was the recommendation for the abandonment of everything that would militate in any way against the creation and maintenance of the terminal storage at Marston Lake. Marston Lake has an earthen embankment. It is as safe against destruction as it would be possible for any storage reservoir to be, because the embankment is low, old, and has settled very thoroughly. It stores some six billion or more gallons of water, and by raising its embankment slightly, this storage can be considerably increased. It lies at an elevation well adapted to supply water by gravity to Denver's distributing reservoirs, located within the city at Ashland Avenue and at Capitol Hill.

Denver's water system has been built up piece-meal and its component parts have never been properly co-ordinated in one comprehensive and harmonious design. The fact that there were at times four different companies in simultaneous operation, combined with long and bitter litigation, made it impossible for the companies to develop any one comprehensive plan.

Since the city acquired the plant, the Water Commission has done its best with the inadequate and very much run-down water works which it inherited, but has had no funds with which to carry out any plan for rehabilitating the works or for increasing the supply.

The first installment of the supply system for bringing water from the south to Marston Lake would consist of stretches of cut-and-cover ditch following the curvature of the side hills, the stretches of ditch being connected by siphons across the ravines. The ditch sections would have a capacity of 225 mgd. and the first set of siphons would have a capacity of 75 mgd. Two other sets of siphons of equal capacity would be added later as needed. There is already a good 60-in. wood stave pipe leading from the intake in Platte Canyon at such an elevation that it can supply a limited amount of water to this conduit. Other water from the Platte Canyon Reservoir, delivered into that reservoir by the High Line Canal, in which the city has certain water rights, can be fed into the existing conduits, which, for the remaining period of their useful life, will be maintained to aid in bringing water down to the city, as they do at present.

Later on, with the progressive development of storage on the South Platte watershed, new tunnels and ditches will take the place of the 60-in. wood stave pipe and will supply to their full capacity the ditches and siphons leading to Marston Lake. From Marston Lake, a 66-in. conduit will be laid to the south limits of the city, where it will split into conduits of smaller size, connected to the distribution mains and reservoirs in the city. Two additional conduits of like size will be built as required. At least half a million dollars will be spent in the city itself, improving the local distribution facilities.

The slow sand filters at Platte Canyon, and the very old wooden tub filters at Willard and Marston Lake, will be replaced by modern fireproof mechanical filters northeast of Marston Lake.

Marston Lake is a pivotal and very important feature of the proposed new system. It will store a month's supply for Denver when the consumption is twice what it now is, and will thus give ample time to repair any break in the conduit lines leading down to it from the south. There is, however, no adequate outlet from Marston Lake and such an outlet is essential. It is exceedingly important not to have to drain or lower Marston Lake while building the outlet. At the same time it is vitally necessary that the integrity of the embankment be not endangered during construction. Consequently, a scheme was devised by which a crib, open at the bottom at first, should be sunk by excavating from within, without any pumping whatever; and when this crib should have reached its level, it was then arranged to close its bottom with concrete and to connect to this crib two rows of piling extending 140 feet or more into the lake. Then, by special devices, two lines of 72-in. cast iron pipe were to be lowered from trusses set across these rows of piles. When the pipes reached their place, they would be connected to the crib. From the crib there would lead out to the north three lines of 60-in. pipe, two of which would be plugged for the present, one of them being extended to the first unit of the filtration plant.

This first unit would have a nominal capacity of 64,000,000 gals. per day, based on a rate of 150,000,000 gals. per acre per day. Ample aeration and sedimentation would be provided. Aeration is particularly necessary in treating the Denver waters, because of the formation of algae in the shallow portions of the large lakes. From the filtration plant the first conduit would lead to the southwest corner of the

city. The filter plant could be increased by building on extensions, bookcase fashion, up to 192,000,000 gals. of rated capacity. Denver is now operating its old wooden filters at rates running up to 200,000,000 gals., per acre per day, and obtaining very fair results. It is possible that with better aeration and coagulation, better water could be obtained at even higher rates.

In addition to the $7,300,000 required for these immediate developments, something like $30,000,000 more will be required for the completion of the larger problem, estimated to supply Denver when it shall have a population of one million.

Norfolk

Prior to the war with Germany, Norfolk's water supply had for many years been taken from shallow lakes northeast of the City. At the same time the Norfolk County Water Co. was supplying territory to the north and east of the City, and some territory within the City limits itself, with water which it obtained in part from wells and lakes near Norfolk's lakes, and in part from the North Landing River through eight miles of 24-in. wood stave pipe leading to the company's pumping station.

The Company was thus competing with the City not only in territory outside of the City and through which some of the City's large mains extended, but actually within the limits of the City itself. Furthermore, the City's sources of supply were deficient in watershed and stream flow, but were equipped with a surplus of storage capacity; whereas, the Company's relatively important watershed on the North Landing River was without adequate storage and without any suitable site for developing storage.

It was obviously to the interest of the City of Norfolk to purchase the plant of the Norfolk County Water Company and consolidate the two systems, and the writer, who had been especially assigned by the War Industries Board to the development of water supplies for all Government activities in the Hampton Roads District, including the Army, Navy, Housing Corporation, and Shipping Board, strongly urged the consolidation of the two properties as the quickest means of securing a much needed increase in supply to meet the war time necessities.

Owing to a delay (in no way the fault of the City) in completing the pumping station necessary to deliver the North Landing River waters into the Norfolk lakes, and also to an unprecedented drought, the City found itself short of water in the winter of 1919-1920. As the result of complaints of insufficiency of supply at the Naval Base, where the per capita consumption was over 250 gals. per day as against less than 75 gals. per day in the City of Norfolk proper, a Congressional Committee met in Norfolk to consider the curtailment of naval activities in that vicinity. The speaker was called upon to testify at the hearings, at which it was satisfactorily demonstrated that the City within a short time would be in a position to supply even the excessive requirements of the Naval Base.

As an evidence of its good faith, Norfolk installed immediately, at a cost of nearly half a million dollars, an emergency connection to the Dismal Swamp Canal, knowing when it did so that no permanent use would ever be made of this water, which contains at times upwards of 400 parts of swamp color.

In the meantime the writer was called upon to report on the best method of making a large and permanent increase in the City's water supply, and one which should be susceptible of development to meet the growing needs of the City for practically all time to come. His report recommended the immediate construction of the Lake Prince project, a project which had long been dear to the heart of Mr. Walter H. Taylor, Norfolk's very efficient City Engineer and Director of Public Works.

The report having been approved, work was promptly started on the plans and specifications in the office of the Director of Public Works, the writer being retained as Consulting Engineer to revise or approve the plans and construction methods. Most of the plans were prepared originally in Mr. Taylor's office, Mr. Norman Z. Ball, with a staff of draftsmen, working under Mr. Taylor in the design of the various portions of the system. The construction work was under the direct supervision of Mr. Taylor, assisted by Messrs. David A. Decker, Norman Z. Ball, W. R. Galt, John D. Miller, John W. Vaughn and others.

The Norfolk Naval Base lies to the north of the City, the Norfolk lakes to the northeast, and the new Lake Prince development to the west. Norfolk's supply, amounting to a minimum of 14,000,000 gals. per day of available supply in a dry season, is taken from the lakes to the northeast, supplemented, as stated, by

the water from North Landing River, which is brought down into these lakes. The available water supply from the existing sources was barely sufficient for present needs and no more water could be developed to the east of the City. There was one small stream feeding Lynnhaven Bay that might have been utilized, but apart from the fact that it was not large enough to pay for its development, the importance of the local oyster industry would probably have prevented its use. The two streams which Mr. Taylor had long ago selected as best for the supply lie 20 miles to the west. As the initial step in the program it was decided to dam the southerly one of these two streams, thus forming the reservoir now known as Lake Prince, and to pipe the water thence down to the City.

The next development will be the damming of the northerly stream to form Lake Bensten, connecting it with Lake Prince by a tunnel. Following that, water can be pumped into the Lake Prince watershed from the Blackwater and Nottoway Rivers, which have a watershed of 400 square miles. The average rainfall is upwards of 40 ins., and the development of all of these streams will provide enough water for nearly a million people. A pipe line eight miles in length will bring the waters of the Blackwater and the Nottoway into the watershed of Lake Prince.

The Lake Prince dam is about 30 ft. high, with a spillway some 200 ft. in length, at an elevation of 25 ft. above the tide. A small electric pumping station delivered water into the pipe line leading to the City. The pipe line has a capacity, with 200 ft. head at the upper end, of about 16,000,000 gals. Lake Prince will store 3,700,000,000 gals., and will give, with that storage, more than the 16,000,000 gals. required. The damming of the next stream to the north, and the completion of the tunnel from it to Lake Prince will add another 14,000,000 gals. With 14,000,000 gals. per day from the lakes to the east, 16,000,000 from Lake Prince, and 14,000,000 gals. from Lake Bensten the total supply would be 44,000,000 gals. and not until Norfolk's requirements shall have reached this amount will it be necessary to bring additional water from the Nottoway River.

There was a good deal of food for thought in the selection of the proper sort of pipe for the line from Lake Prince to the City. Most of the line is 36 ins. in diameter, while parts of it for various reasons were made only 30. We had at our disposal cast iron pipe at an enormous price; reinforced concrete pipe, a somewhat untried article at that time; and wood stave pipe, of which everybody was more or less suspicious. A careful analysis was made of the relative costs of these three types of pipe, and their advantages and disadvantages were stated, and were then, for the purposes of comparison, reduced as nearly as possible to dollars and cents. After allowing for the shorter life and greater vulnerability of wood stave pipe, offsetting that to some extent by the fact that the capacity of cast iron mains is less per inch of diameter in the beginning, and decreases very rapidly in the Norfolk territory, because of the acids in the swamp water; taking into consideration as well as we could the unknown factors with regard to reinforced concrete pipe, we finally determined that if the cost of wood stave pipe would be represented by about 10, the cost of concrete pipe would be represented by about 11, and the cost of cast iron pipe by 20. This comparison was made when the price of cast iron pipe was about $73 per ton, f. o. b. Norfolk.

As a result, it was decided to use wood stave pipe in those parts of the line where it seemed absolutely certain that its use would be attended by the least possible danger. Analyses of the soil were made and all of the conditions were considered as carefully as possible, and we finally used 52,000 ft. of wood stave pipe, about 32,000 ft. of reinforced concrete pipe, and 13,000 ft. of cast iron pipe, approximately half of which was submarine pipe.

The laying of all of the submarine pipe was carried on under the direction of Mr. Taylor, the writer having practically nothing to do with it, except to give a suggestion or two from time to time. The work was most efficiently and successfully executed. When the makers of concrete pipe submitted their first proposal, the only pipe they had to offer was one in which bars or wire mesh construction were the only reinforcement. They were loath to recommend this reinforcement for pipes designed to carry more than 110 ft. of head, not because they were afraid of any excessive tensile stresses in the steel, but because they feared they could not entirely prevent leakage through the thin and more or less porous concrete walls.

At Norfolk they developed a pipe in

which a portion of the reinforcement was put into a thin steel shell, electrically welded. The results with that pipe were really very satisfactory, and after that pipe was introduced we bought more concrete pipe than we had originally planned to buy, and put it across territory where it would have to carry upwards of 150 ft. head.

The official leakage tests on the concrete pipe gave an average leakage throughout the entire 33,000 ft., under the maximum working pressure, of 83 gals. per 24 hours per inch of diameter and per mile of pipe. That is an exceedingly good record, and is considerably less than some authorities say that cast iron pipe will leak. The speaker personally believes that well laid cast iron pipe ought to be somewhat tighter than that. As the contractor's bid was based on 125 gals. per 24 hours per inch-mile, he earned a bonus which the City gladly paid.

The leakage on the wood stave pipe lines in Norfolk has never been fully and accurately tested. It was slowly but constantly diminishing at last accounts. When tested last year it was in the neighborhood of 300 gals. per inch-mile, under the maximum working pressures. This year the leakage in 12,800 lin. ft. of 30-in. wood stave pipe at the upper end of the supply line was accurately determined by tank measurement under an average head of about 65 ft., which is about one-third of the maximum head to which the pipe will be subjected. Under this low head the leakage was found to be only 60 gals. per inch mile. As the leakage in most wood stave pipe increases more rapidly with pressure than is the case with other kinds of pipe, it is believed that the leakage in this part of the line under a head of 200 ft. would probably be a little over 200 gals. per inch mile. This the speaker considers a creditable result for pipe of this sort.

Tulsa

The City of Tulsa is conspicuous among American communities of its size for its phenomenal growth and development during the recent past. While this development has resulted, primarily, from the magic wealth of oil, no man can remain long in the City without realizing that the personnel and civic pride of those who are prominent in the City's affairs have had far more to do with the City's rapid strides than would ordinarily be the case in such a community.

Not only is the City one of the most modern and up-to-date in this country, but on every side one is impressed with the energy, intelligence and patriotic teamwork of the leaders of all of the civic organizations.

For years past the City has been getting its supply from the Arkansas River. The water is made perfectly safe and sanitary by filtration, but as it contains from 300 to 3,000 parts per million of salt, it can not be used for drinking nor for boiler purposes. It has been estimated that the citizens of Tulsa pay annually from $350,000 to $500,000 for bottled waters. In 1921, the citizens voted a bond issue of $6,800,000 to bring water 60 miles from Spavinaw Creek in the Ozark Mountains. As at that time the population of the City was not much over 75,000, this bond issue represented the assumption of an obligation of more than $90 for every man, woman and child in the City.

It is doubtful whether history could show a larger per capita bond issue for water works extensions in any city of comparable size. New York's $175,000,000 for her Catskill supply seems small when the relative populations of the two communities are considered.

The citizens of Tulsa would not, however, have voted this large bond issue had not the Chamber of Commerce assured them that the work would be placed in the hands of men of standing so high in the community that all their acts would be above suspicion. The personnel of the present Spavinaw Water Commission complies with this specification to a remarkable extent. It is composed of men of proven courage, intelligence and integrity, practically all of whom are at the head of some of the City's most important business institutions; and these men are giving constantly, unselfishly, and without compensation, their valuable services to the enterprise.

How they stood the acid test was shown when at a letting of about five and one-half million dollars worth of contracts, on Sept. 25, 1922, they had the wisdom and courage to reject unanimously a bid on six contracts which was apparently $900,000 lower than the aggregate of the six next lowest bids on each of these contracts; and also to reject unanimously a bid on two contracts which was apparently, though not actually, $150,000 lower than the next lowest bid on the same two contracts.

The original report on which the Spavinaw project was based was prepared by Messrs. Trammell and Holway, who were later retained to prepare the plans and specifications and supervise the work of construction, the writer being retained by the Board as Consulting Engineer on the plans, specifications and supervision.

Pursuant to an understanding arrived at between the Board and Messrs. Trammell and Holway, subsequent to the lettings, Mr. Holway now has direct charge of the construction work, Mr. Trammel being retained to advise Mr. Holway when necessary. The writer, as Consulting Engineer for the Board, is under obligation to visit the work twice a month during the progress of construction. The work has started all along the line and is being pushed with all the energy possible.

The Grand River is the western limit of the Ozark Mountains, the hills coming down sharply to its banks. Spavinaw creek is a beautiful mountain stream draining about 400 square miles, and having a minimum flow of perhaps 17,000,000 gals. per day. The water is clear, reasonably soft and almost never turbid. About 11,000,000,000 gals. of water will be impounded by a dam 50 ft. in height, with a spillway 800 ft. long. This dam is about 3,500 ft. in total length. The spillway section will be of solid concrete, gravity type, and there will be about 2,700 ft. of earthen embankment with heavy concrete core wall. From this dam a gravity pipe line, the first 28 miles of which will be 60 ins. in diameter, leads toward the City. At the lower end of the 60-in. pipe there is a tunnel which, with its approaches, is 10,000 ft. in length, and which will have an inside diameter of 84 ins.

From this tunnel westward there will be 25 miles more of 54-in. concrete pipe, which will bring the water to an earthen reservoir at Mohawk. This reservoir will have a capacity of 500,000,000 gals. At that point a new pumping station will be built, and at some later date a filtration plant. Tentative layouts for the aerators, pumping station and future filtration plant have been made. The water will be pumped from this station against a total head of 350 ft., including friction, through four miles of 30-in. force main, into a 10,000,000 gal. reinforced concrete distribution reservoir, with concrete roof covered with soil and turf. These items, together with some large additions to the distribution system, will complete the new development for the present, although later on a filtration plant will be built opposite the Mohawk pumping station.

The little town of Spavinaw, Okla., will be flooded by the waters of the dam. This is one of the oldest towns in that comparatively new country. There is one old stone building there said to have been built by the Mormons when they trekked through toward Utah. About 1,800 acres of land will be flooded, and some 800 acres of that will have to be cleared.

The City Water Board very wisely and economically acquired the flowage rights in old Spavinaw by starting a new town, which the Board equipped with water supply and sewerage and sanitary facilities, and laid off in attractive streets. The Board gave two lots in the new town for one in the old, and removed the buildings besides. Land damages and property damages were disposed of very cheaply in that way, and the new town now contains many more houses than the old one, and they are building them as fast as they can put them up.

The foregoing matter is from a paper presented by Mr. Maury before the recent annual meeting of the American Water Works Association.

FOR THOSE WHO ARE FOND OF FINE OLD WRITING

By Harry W. Levy, Engineer-in-Charge, Division of Design, Borough of Manhattan, Municipal Bldg., New York, N. Y.

—Introduction—

Probably one of the first real efforts toward a comprehensive City Plan for any of our large cities was made by the Commissioner of Streets and Roads in the City of New York back in 1807.

From the year 1624, the date of the first real effort at colonizing in America by the Dutch, up to the adoption of this comprehensive street plan, or as it is familiarly termed the "Commissioner's Map of 1807," the development of the street system of New York City was merely a matter of growth, a condition in which we find a parallel in the start of all old cities.

John Randel, Jr., was the engineer employed by the Commissioners to make the necessary surveys and maps, set monuments, etc., and it is believed that the successful termination of this great work, within four years of its inception, was largely due to his efforts and ability.

The governing reasons for the adoption of the rectangular street system are quaintly but forcefully described in the report which is appended hereto. The reader should bear in mind that two of the principal factors to be considered in city planning today, namely, vehicular traffic and density of population with its intensive building development, had not at that time become manifest.

"The Commissioner of Streets & Roads in the City of New York appointed in and by an act relative to improvements touching the laying ou. of streets and roads in the City of New York and for other purposes passed the third day of April in the year of our Lord one thousand eight hundred and seven according to the Form and Effect of the said act Remark on the Map hereunto annexed:

"That as soon as they could meet and take the oath prescribed they entered on the duties of their office and employed persons to make surveys of Manhattan Island, which they personally reconnoitered, so as to acquire the general information needful to the correct prosecution of their work which has been much delayed by the difficulty of procuring competent persons on those acconomical terms which they prescribed to themselves, and by seasons peculiarly unfavorable.

"That one of the first objects which claimed their attention was the form and manner in which the business should be conducted: That is to say whether they should confine themselves to rectilinear and rectangular streets or whether they should adopt some of those supposed improvements by Circles, Ovals and Stars which certainly embellish a plan whatever may be their effect as to convenience and utility. In considering that subject they could not but bear in mind that a City should be composed principally of the habitations of man and that strait sided and right angled houses are the most cheap to build and the most convenient to live in. The effect of these plain and simple reflections was decisive.

"Having determined, therefore, that the work should in general be rectangular a second and in their opinion an important consideration was so to amalgamate it with the plans already adopted by individuals as not to make any unimportant change in their dispositions. This if it could have been effected consistently with the public interest was desirable not only as it might render the work more generally acceptable but also as it might be the means of avoiding expense. It was therefore a favorite object with the Commissioners and pursued until after various unfruitful attempts had proved its extreme difficulty, nor was it abandoned at last but from necessity. To show the obstacles which frustrated every effort can be of no use. It will perhaps be more satisfactory to each person who may feel aggrieved to ask himself whether his sensations would not have been still more unpleasant had his favorite plans been sacrificed to preserve those of a more fortunate neighbor.

"If it should be asked why was the present plan adopted in preference to any other, the answer is, because, after taking all circumstances into consideration, it appeared to be the best, or, in other and more proper terms, attended with the least inconvenience.

"It may to many be matter of surprise that so many vacant spaces have been left and those so small; for the benefit of fresh air and consequent preservation of health. Certainly if the City of New York were destined to stand on the side of a small stream, such as the Seine or the Thames, a great number of ample places might be needful. But those large arms of the sea which embrace Manhattan Island render its situation in regard to health and pleasure, as well as to the convenience of commerce, peculiarly felicitous. When therefore, from the same causes, the price of land is so uncommonly great, it seemed proper to admit the principles of acconomy to greater influence than might, under circumstances of a different kind, have consisted with the dictates of prudence and the sense of duty.

"It appeared proper, nevertheless, to select and set apart, on an elevated position, a space sufficient for a large reservoir when it shall be found needful to furnish the city, by means of aqueducts or by the aid of hydraulic machinery, with a copious supply of pure and wholesome water. In the meantime, and indeed afterwards, the same space may be consecrated to the purposes of science when public spirit shall dictate the building of an observatory.

"It did not appear proper only, it was felt to be indispensable, that a much larger space should be set apart for military exercise as also to assemble, in case of need, the force to defend the city. The question therefore was not, and could not be, whether there should be a grand

parade but where it should be placed and what should be its size, and here again it is to be lamented that in this late day the parade could not be brought further south and made larger than it is without incurring a frightful expense.

"The spot nearest to that part of the city already built which could be selected, with any regard to acconomy, is at the foot of those heights called Inklangbergh in the vicinity of Kips Bay. That it is too remote and too small shall not be denied; but it is presumed that those who may be inclined to criticism on that score may feel somewhat mollified when the Collector shall call for their proportion of the large and immediate tax which even this small and remote parade will require.

"Another large space almost as necessary as the last is that which, in no distant period, will be required for a public market. The City of New York contains a population already sufficient to place it in the rank of cities of the second order, and is rapidly advancing towards a level with the first. It is perhaps no unreasonable conjecture that in half a century it will be closely built up to the Northern Boundary of the Parade, and contain four hundred thousand souls. The controuling power of necessity will, long before that period, have taught its inhabitants the advantages of deriving their supplies of butchers' meat, poultry, fish, game, vegetables and fruit from shops in their neighborhood. The dealers in those articles will also find it convenient, and so will those from whom they purchase, to meet at one general mart.

"This has a tendency to fix and equalize prices over the whole city. The carcass butcher, gardner, farmer, etc., will be able to calculate with tolerable accuracy on the rate at which the supplies he furnishes can be vended, and the reasonable profit of the retailer being added, will give a price for the consumer; varying rather by the quality of the article than by any other circumstance. It is no trifling consideration that by this mode of supplying the wants of large cities there is a great saving of time and of the articles consumed.

"To a person engaged in profitable business one hour spent in market is frequently worth more than the whole of what he purchases, and he is sometimes obliged to purchase a larger quantity than he has occasion to use, so that the surplus is wasted. Moreover the time spent by those who bring articles of small value from the country in retailing them out bears such great proportion to the articles themselves as to increase the price beyond what it ought to be. In short, experience having demonstrated to every great aggregation of mankind the expediency of such arrangement it is reasonable to conclude that it will be adopted hereafter, and therefore it is proper to provide for it now. Neither is it wholly unworthy of consideration that the establishment of a general mart will leave open the spaces now appropriated to that object in parts of the city more closely built than is perfectly consistent with cleanliness and health.

"The place selected for this purpose is a salt marsh and from that circumstance of inferior price tho in regard to its destination of greater value than other soil. The matter dug from a large canal thro the middle, for the admission of market boats, will give a due elevation and solidity to the sides; and in a space more than three thousand feet long and upwards of eight hundred wide, there will, it is presumed, after deducting what is needful for the canal and markets, be sufficient room for carts and wagons without incommoding those whose business or curiosity may induce them to attend it.

"To some it may be a matter of surprise that the whole island has not been laid out as a city. To others, it may be a subject of merriment that the Commissioners have provided space for a greater population than is collected at any spot on this side of China. They have in this respect been governed by the shape of the ground. It is not improbable that considerable numbers may be collected at Harlem before the high hills to the south westward of it shall be built upon as a city, and it is improbable that (For centuries to come) the grounds north of Harlem Flat will be covered with houses. To have come short of the extent laid out might, therefore, have defeated just expectation; and to have gone further might have furnished materials to the pernicious spirit of speculation."

—Concluding Notes—

When one stops to consider the times and basic facts then at hand to guide these commissioners in laying out their street system, it must be admitted that this is a remarkable piece of city planning. The population at that time was largely concentrated in the area south of

Houston Street. Provisions were brought in mostly by means of sailing vessels which docked in the section along the East and North Rivers. The main traffic was to and from the water front. The principal means of transportation were by stage coach, carriage, wagon and cart. Later it became apparent that more north and south avenues should have been provided. Therefore, Madison and Lexington Avenues were cut through midway between 3d and 4th avenues and 4th and 5th avenues, as laid down on the Commissioner's Map, before property development had made such a proceeding financially impossible, as would be the case today.

In a recent report by the Chief Engineer of the Board of Estimate and Apportionment, he states that "it has been frequently urged that if the street system of 1807 had been planned in such a way as to locate the short blocks along the east and west streets instead of the reverse, there would have been, say, 40 north and south streets instead of the 15 which we now have at 42d Street, and that in this case there would have been no congestion problem today. This claim is open to very serious question. If the north and south streets had been made 60 feet wide, as it seems likely would have been the case, there would have resulted some 80 lanes of traffic instead of the 55 which we now have, but each lane would have had to accommodate both slow and fast moving vehicles. Of the lanes now available, nearly one-half can be treated as for fast moving vehicles, each adjoining one for those of slower motion, these, in my opinion, providing freer movement to an extent more than sufficient to offset the fact that they are less in number than would have been available if the street system had been reversed."

THE WATER WORKS COAL PILE

By Donald H. Maxwell, Principal Assistant Engineer, Alvord, Burdick & Howson, Engineers, 8 S. Dearborn St., Chicago.

The recent increased cost of coal and the troubles experienced in getting a sufficient supply and of the right quality have brought the coal pile forcefully to the attention of the water works superintendent.

Although the amount of coal required for water works pumping in the United States seems small by comparison with the estimated total coal consumption for all purposes of about six tons per capita, it is nevertheless a very considerable amount, and is estimated at approximately three million tons per year. In future years it is likely that much more than this will be required, for even if better economy can be practiced in the use of coal by water works plants, the savings will be more than offset by the increased demand for water by the growing city population. This city population may reasonably be expected to at least treble. When that time arrives the coal consumption for public water supply on the present basis will be approximately ten million tons per year.

In the meantime the general expansion of industry tends to increase the market for coal while the supply is well understood to be definitely limited and capable of development only at increased cost as the more accessible veins and better grades are worked out.

It is thus apparent that the problem of the coal supply and of the economic utilization of coal in the water works plant is not one of momentary interest alone but destined to be of constantly increasing importance.

Coal Savings Possible

There is no doubt but that the water works coal pile, taken as a whole, can be very much reduced. The consulting engineer is in a position to note many instances where pumping plant efficiency might be increased and others where pumpage might be reduced. It is rather striking, for instance, to note that in our second largest city, supplied with water by ten large pumping stations of good efficiency the waste of water in distribution is so great that the estimated possible saving in coal by metering the services would amount to nearly 100,000 tons a year. This plant is, of course, exceptional but instances taken at random will be given later on that will be sufficient to indicate that there is in the aggregate, a very considerable waste of coal in water works plants that can be overcome by giving closer attention to boiler room economy, to efficient pumping and to the distribution of water without unnecessary waste.

Developments in Steam Plant Economy

The first requisite to coal economy is efficient equipment. Great strides have been made in the development of pumping plant economy since many of our older water works plants were equipped. In contrast to the hand fired return tubular

boiler of small horsepower delivering saturated steam at 80 lbs. pressure to duplex pumps of very low duty, modern practice calls for stokers, water tube boilers in large units, with superheaters and with good accessory equipment for maintaining high efficiency, and delivering steam at from 200 to 300 lbs. pressure and superheated 100 to 200 degs. The steam is utilized in cross-compound or vertical triple pumps with test duties ranging from 120 to 180 million foot pounds per 1,000 lbs. steam.

The effect of this change on the coal pile is shown in part (except for superheat) by the accompanying diagram. This diagram does not take account of such auxiliary equipment as boiler feed pumps and the incidental uses of coal for station heating, etc., nor does it allow for variation in load. The station duty for a given set of equipment would, therefore, be less than indicated by the coal rates shown on this diagram. The diagram is based on coal having 12,000 B. T. U. per pound.

By inspecting the diagram we see that vertical triple expansion engines of 160 million duty using saturated steam supplied by boilers operating at 70 per cent efficiency would require 0.3 tons of coal to pump one million gallons 100 ft. high. On the other hand with compound direct-acting low duty pumps of 30 million duty using steam supplied by boilers of 50 per cent efficiency would require 2.2 tons of coal to accomplish the same result. One plant would consume seven times as much coal as the other to do the same pumping and it is a fact that may of our smaller steam plants compare no more favorably than this with the more modern high duty station.

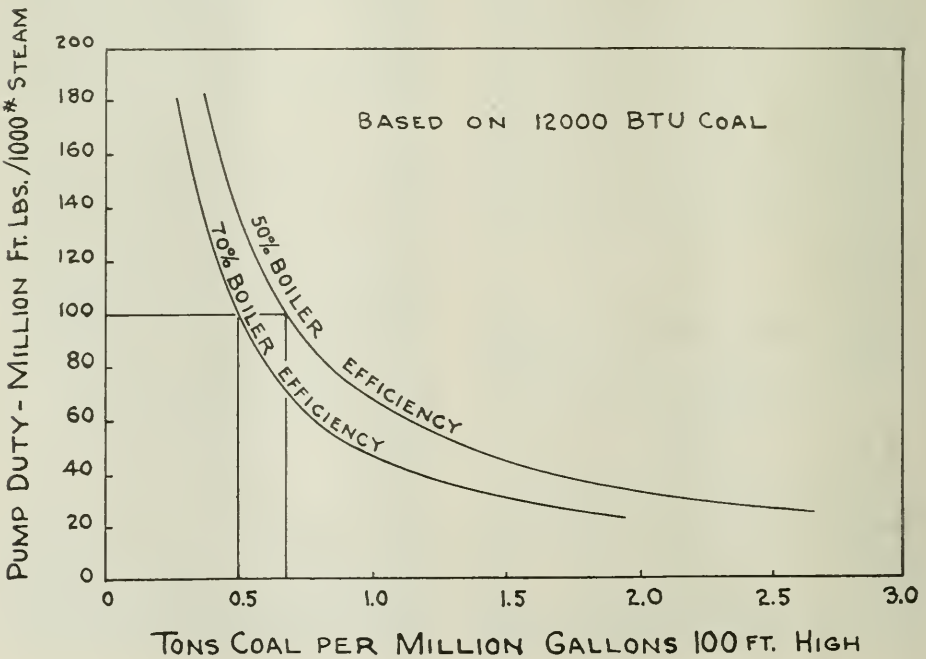
Advantage of High Pressure and Superheat

To understand the advantage in high steam pressure and superheat, it should be borne in mind:

(1) That steam engine efficiency increases with the steam pressure, amounting in turbo-centrifugal pumps, for example, to about 1 per cent decrease in steam consumption for each 10 lbs. increase in steam pressure.

(2) That, in general, it does not take more coal (to an appreciable extent) to generate steam at relatively high pressure than at low pressure.

(3) That engine efficiency increases with superheat, the gain with turbo-centrifugal pumps, for example, being approximately 1 per cent decrease in steam consumption for each 12 degs. increase in superheat. The great advantage of superheated steam in reciprocating engines is that it does away with cylinder condensation (if superheated enough), so that all of the steam entering the cylinder is available to do useful work throughout the stroke.



(4) That the additional heat required to superheat steam is much less than the heat saved by the engine so that there is a saving of coal. Assuming 100 deg. superheat, this fuel saving amounts to about 4 per cent with a turbo-centrifugal unit, 8 per cent with a triple expansion engine and much more with compound and with simple engines.

Limitations of Water Works Plants

The water works plant is long-lived compared to the industrial and electric power plant. The opportunities of business expansion, particularly in electric power production, make it good business policy to use only the most modern and efficient equipment. The coal bill in these plants is a relatively large part of the cost of power and accounts for the wholesale discarding of comparatively new equipment and even entire plants to make way for more efficient units of larger capacity in great central stations that will enable the utility to command more business.

The water works plant cannot be rejuvenated in this sweeping way. The business of selling water is in most cities fully developed and can only increase in proportion to the growth of the city. The water works pumping station represents a comparatively small part of the total plant investment and the coal bill is also a small part, comparatively speaking, of the total annual cost of the entire plant, including fixed charges. Furthermore, the requirements for fire protection make it necessary, particularly in the small plant, to carry a relatively large reserve boiler and pump capacity which is idle most of the time.

From these facts it is seen that the water works plant must move slowly in the procession of increased plant efficiency. Only occasionally when an entirely new plant is built to replace an outgrown and obsolete plant does the engineer have the joy of doing what he would like to do in making the plant up to date in efficiency of equipment. The more usual case involves more or less important additions to existing equipment, the limitations of this old equipment influencing at times very largely the character and efficiency of the new. It is not always financially practicable to change over to 200 lbs. boiler pressure and 100 degs. superheat, for instance, in a plant with heavy investment in low pressure pumps and boilers that are still good. The fixed charges on proposed new equipment must always be weighed against the estimated saving in cost of coal, and coal is not high enough yet to warrant the sweeping replacements in the average water works plant that have been good business policy in some electrical power plants.

Planning for the Future

Even though radical changes in pumping station equipment may not be justified when renewals are necessary, the superintendent has an opportunity at such times which should not be lost sight of, to map out an improvement program involving the entire plant. It would be most desirable, for instance, in replacing a boiler to make a survey of the plant and its future requirements and as a result, perhaps find it worth while to install a boiler, at comparatively slight increased cost, capable of withstanding a future higher steam pressure and arranged for the installation at a later date of superheaters. Then when the time comes to make pump replacements or additions the boilers will not be a handicap. Judicious provision for the future in this way will do much in the course of time to improve the small water works station efficiency without sacrificing useful equipment.

Boiler Plant Operation

Meantime the water works operator must be contented to make the best use of the equipment now in hand. Even though the low pressure plant with low duty machinery must continue operating on this basis for some years a great deal can often be accomplished in these plants to reduce coal consumption by close attention to the details of operating that make for efficiency. The watch-word throughout the plant should be: "save the heat units." It might be said that intelligent and conscientious operation of a hand-fired low efficiency boiler installation is even more important for coal economy than in a plant with high efficiency equipment.

Coal saving is not possible without measuring and recording the internal workings of the plant. Between the heat input and measure of work output, there may be very large preventable waste of energy amounting to from 25 to 50 per cent of the coal pile in a poorly maintained plant. So it is not sufficient to know merely the tons of coal purchased and the plunger displacement, and yet, astonishing as it may seem, plants are occasionally met with in which even this meagre information is not obtainable in a satisfactory manner.

The efficient operator must know the pounds of coal burned per hour for a given heat output in steam. He must

know whether his customary methods of firing give the best results with the fuel at hand. He must know the effect of his practice in draft regulation as to whether the boiler is being unnecessarily cooled by too much excess air on the one hand, or on the other hand whether unburned gases are being wasted up the stack from insufficient supply of air to the furnace, and among other things he must know the effect of removing soot and boiler scale and how often it pays as a practical proposition to do this.

In a word, the operator should know whether he is wasting coal in the boilers. To find this out he needs the equipment and the interest to make routine boiler tests and periodic flue gas analyses.

An intelligent boiler room force and careful training in efficient methods are essential to economical operation. Furthermore, a suitable bonus system based on coal saved would be a valuable stimulus to interest in a coal saving program, if the possible savings seem sufficiently great to warrant it.

Pump Room Operation

Pump room operation has a very large influence on the coal pile. The coal robber in this part of the plant is pump slip, though the preventable loss at the steam end may also be considerable.

The output of every pump room should be metered at the station unless there is some other convenient method of checking up on the pump slip, at frequent intervals. The use of venturi meters on discharge lines has become quite general, but there are still many plants which lack proper equipment of this kind. These plants are as a rule paying heavily for it in the coal pile.

The writer has had occasion to observe some startling results from high pump slip, and there is good reason to believe that this is one of the principal causes of coal waste in many of the stations that lack proper means of measuring the water delivered by the pumps.

Table I shows the result in one plant of reducing pump slip. The records of this plant for several years show a continual increase in the tons of coal burned per million gallons pumped. The coal bill finally became so high that it was decided to have the pumps rebuilt. The effect of improved efficiency of the steam end and of reducing the pump slip is very strikingly illustrated by a reduction in the coal consumption amounting to 67 per cent of the coal burned in 1922. Comparison of the 1922 pumpage with that of the two

TABLE 1—EFFECT OF REDUCING PUMP SLIP ON THE COAL PILE

Year	Plunger Displacement, Million Gals.	Coal Burned Tons
1919	263.1	1,124
1920	299.9	1,288
*1921	304.8	1,264
1922	237.9	770

*Rebuilt pump back in service in November.

Coal saved in 1922, 518 tons—67% of 1922 coal pile.

preceding years shows a very marked reduction in pumpage as indicated by plunger displacement.

Table II shows the effect on the coal pile of introducing a high duty pump to do the work formerly carried on by low duty pumps. In this plant under the same conditions of operation the high duty pump accounted for a saving of over 1,000 tons per year amounting to 25 per cent of the 1914 coal pile.

Table III is a rather striking illustra-

TABLE II—EFFECT OF HIGHER DUTY PUMP ON THE COAL PILE

Year	Pumpage Mil. Gals.	% of Time New Pump Used	Coal Tons	Coal Per Mil. Gals. 100 ft. High Tons
1910	1,839		4,626	1.01
*1911	1,919		4,873	1.01
1912	2,090	60.9%	4,749	0.965
1913	2,241	90.7	4,403	0.842
1914	2,272	92.6	4,562	0.810

*Cross-Compound pump of 142 million test duty installed.

Coal saved in 1914, 1,030 tons—25% of 1914 coal pile.

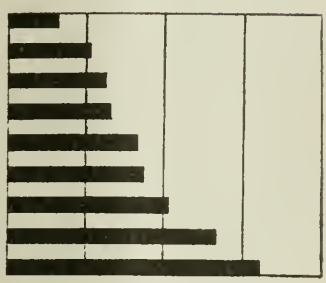
tion of the very large coal saving sometimes possible in a comparatively small plant by eliminating excessive slip in a high test duty cross-compound pump. The saving in this case was at the rate of approximately 1,600 tons per year, although inspection of the records tended to show that the excessive slip found on test had lasted only about four months. The record of plunger displacement indicated, however, that up to within one week of the test the slip had been materially higher than indicated by the test, and had been partly corrected by replacing pump valves.

TABLE III—VALUE OF TESTING PUMP SLIP AS MEASURED BY THE COAL PILE

Average daily pumpage	12,000,000 Gals.
Slip	3,750,000 Gals.
Slip reduced to	700,000 Gals.
Total head 153 ft.	
Coal per mil. gals. 100 ft. High	0.923 Tons
Coal saved per year	1,570 Tons

TABLE IV—COMPARISON OF COAL CONSUMPTION OF STATIONS DOING DOUBLE PUMPING.

Plant	Av. Daily Pumpage Mil. Gals.	Total Head Ft.	Coal Tons	Coal per Mil. Gals. 100 Ft. High Tons
A	8.83	256	5,317	0.61
B	4.98	240	2,672*	1.05
C	2.3	280	2,905	1.23
D	0.78	263	648	1.30
E	1.34	221	1,768	1.63
F	2.81	140	2,500	1.74
G	8.98	180	11,940	2.02
H	3.5	190	6,400	2.65
I	2.39	253	7,060	3.2



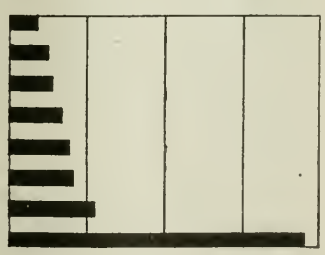
* 7 Months Period

Table IV is shown to illustrate the great difference in coal consumption between stations of the same general type. These are all double pumping stations in small or moderate sized cities operating for the most part under direct pressure. Plant "A" is an eastern plant burning Pennsylvania coal. The others are western plants burning Indiana or Illinois coal. The high coal consumption of plant "G" may be partly attributed to wide range in low lift pump head. In Plant "H" it is due partly to poor plant design. In Station "I" the poor showing is due in part to very inefficient low lift pumping from the use of over-sized electric centrifugals, the low lift pumping being accomplished at an overall efficiency of 15 per cent for pumps and motors.

Table V is shown to indicate the typical low coal rate that is expected of well designed and operated modern stations doing single pumping, and to contrast with them the old fashioned stations with low pressure boilers and low duty pumps. Plant "A" is the North Point station at Milwaukee, equipped with vertical triple expansion engines of high test duty of about 180 million foot pounds. Plant "B" is an efficiently operated small station burning Pennsylvania coal in hand-fired boilers and pumping with cross-compound engines against constant head. "C" represents the newest and most efficient of the Chicago pumping stations, pumping direct pressure with vertical triple and turbo-centrifugal pumps against a total lift of about 115 ft. Steam is generated by water tube boilers operating at 175 lbs. pressure. "E" represents the average of all Chicago stations considering steam pumping only. At three of the Chicago stations a large amount of pumping is done by motor driven centrifugals using central station current. At these stations the coal duty has been greatly decreased from their former performance which is probably to be accounted for by the unfavorable load on the steam plant. 22nd St. now shows a coal rate of 1.41 tons per

TABLE V—COMPARISON OF COAL CONSUMPTION OF STATIONS DOING SINGLE PUMPING.

Plant	Av. Daily Pumpage Mil. Gals.	Total Head Ft.	Coal Tons	Coal per Mil. Gals. 100 Ft. High Tons
A	62.6	211.5	18,954	0.399
B	3.86	240.	1,800	0.53
C	76.5	115.3	18,452	0.572
D	10.9	283.5	3,237*	0.684
E	603.	109.2	184,368	0.768
F	6.15	251.	4,562	0.810
G	0.65	294.	770	1.10
H	0.5	217.	1,500	3.79



* Five months period

million gallons, 100 ft. high compared with 0.83 in 1910 and 68th St. shows a coal rate of 1.3 tons compared with 0.85 in 1910.

Plant "D" is the new Des Moines station with stoker fired boilers, 200 lbs. steam pressure and 100 degs. superheat pumping with turbo-centrifugals of 143 million foot pounds test duty. It should be noted that this plant operates on Iowa coal containing from 8,300 to 8,800 B. T. U. per pound. The boilers on test showed 72 per cent efficiency at full load and 66.5 to 168 per cent overload. The plant operates direct pressure. It should be noted particularly that this plant burns a much lower grade of coal than the Illinois steam coal used at Chicago.

Station "F", the old Des Moines pumping station, should be compared with Station "D". This station, with hand-fired return tubular boilers and a cross-compound pump of 140 million test duty operating on 125 lbs. steam pressure required 20 per cent more fuel than the new station to accomplish an equivalent amount of pumping.

Station "G" indicates good performance in a fairly well maintained plant operating under 90 lbs. steam pressure and duplex compound pumps in good condition operating direct-pressure under a high head. Station "H" in contrast to "G" represents very poor performance in a plant having equipment of the same general character and burning just as good coal. This latter plant showed 50 per cent boiler efficiency on test and 25 per cent pump slip.

These few illustrations show that although some pumping plants are operating on a highly efficient basis, there are others where large quantities of coal are being wasted. In some of these instances the fault lies in the plant installation, and can only be overcome by putting in better equipment. In others a great deal can be accomplished to improve the plant efficiency by systematically checking up on pump slip, boiler firing methods, draft regulation, and all the other details of operating that affect the size of the annual coal pile.

The foregoing paper by Mr .Maxwell was presented at the recent annual meeting of the American Water Works Association.

A COMPARISON OF FLOOD CONTROL MEASURES

By Harry Taylor, Brigadier General, U. S. Army, Assistant Chief of Engineers.

It may be well to ask at the outset what are the causes of floods? The answer is, briefly, abnormal rainfall. This rainfall may be either in the shape of what is popularly known as a "cloudburst," such as occurred at Pueblo, Colo., in June, 1921; in the shape of heavy, long-continued rains, such as produced the floods in the lower Mississippi River in February and March, 1922, or heavy rains falling on snow or frozen ground, such as produced the floods which devastated Dayton and other cities of Ohio a few years ago. Warm winds blowing on a heavy blanket of snow may also produce a serious flood. Floods of this character are most common in the Pacific Northwest where a warm southwest wind, known as a "Chinook" wind, occurs during the winter months and causes the snow on the mountains to melt with great rapidity. The floods caused by the so-called cloudburst are usually local in character and commonly occur on small streams. Floods caused by long, heavy rainfall usually cover a large territory and it often happens that such rainfall will produce a flood in the main stream when none of the tributaries is subject to excessive flood. This occurred recently in the lower Mississippi, when that stream carried an unusual flood, but all of the lower tributaries carried moderate quotas. The floods caused by rains falling on snow or frozen ground generaly affect an area intermediate between the other two types.

Control of Floods

Outside of the Mississippi Valley the people of the United States ordinarily give little thought to the control of floods. It is only when some serious flood occurs that attention is focused on the prevention of a repetition of the disasters caused by such flood, and then the matter is of extreme interest for a short time, with all sorts of remedies proposed. Dayton, Ohio, is one exception. It is characteristic of the American people that when we suffer from any cause such as a flood, a contagious disease, or war, we are wildly enthusiastic for steps to prevent a repetition of the disaster, but as soon as the time of stress has passed, we forget that trouble has occurred and delay taking the steps necessary to prevent a repetition. This is well illustrated by the present attitude of the

American people toward the army. Five years ago there was nothing too good for the army. Today, many seem to desire its absolute abolition, forgetting that it is an insurance against trouble in the future. I wish I could believe that we will never be involved in another war. I wish also that I could believe we will never have a disastrous flood, but I am certain that floods will come until we know how to control the distribution of rainfall, and I am equally certain that the services of the army will be required in the future.

The control of floods appears to be considered by the majority of our people as a simple problem. It is true that different people have different solutions. The most common solutions are reforestation, reservoirs at the sources of the streams, levees, outlets or spillways, and straightening and enlarging river beds. We frequently have other solutions suggested, as for example, one proposed to install boilers on the banks of the Mississippi River to evaporate the flood waters, thus causing clouds to form and produce rain over the Middle West where needed.

In the solutions proposed, the control of floods is quite commonly linked with other beneficial effects, most commonly with waterpower development. It is generally assumed that the same work which will control floods will produce power, improve navigation, and provide drainage. One very troublesome problem that comes before the engineer department is the problem of the Fox River and Lake Winnebago, Wisconsin. At the outlet of Lake Winnebago are constructed two dams provided with gates for controlling the water outflow from this lake. The lake is surrounded by flat land over which the flowage rights were purchased and paid for by the United States some 50 years ago. Since that time these lands have been sold and the buyers in many cases have apparently made their purchases unaware of the rights of the government. Invariably, during floods on this stream, the people above the dams insist on the gates being open so as to permit the water to flow out rapidly; the people below the dams insist on the gates being closed so as to prevent the water from coming down on them; power interests on the lower river desire to have the water retained and released during periods of low water for the purpose of developing additional power; for the benefit of navigation, the flow should be as uniform as possible.

Reforestation Not a Practical Remedy

With reference to reforestation, I desire to say that I am a thorough believer in a sensible and sane system of reforestation. I believe that the proper exploitation of our few remaining forests and intelligent reforestation is one of the great needs of the country. Reforestation has sufficient merit in itself to stand on its own feet and should not be confused with flood control. The price of lumber today is a sufficient argument for planting trees without attempting to associate forestry with the climate or with flood conditions on our rivers.

There appears to exist in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation. The influence of forests on stream flow has been extensively discussed both by European and American engineers since Gustav Wex, imperial and ministerial counselor and engineer of the improvement of the Danube River at Vienna in 1873 submitted a series of papers on the decrease of water in springs, creeks and rivers which were translated into English by the late General Weitzel, C. E.

There is a great diversity of opinion on the subject, some maintaining that the cutting of forests will ultimately convert Europe into a Numidian desert, while other claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application is fraught with great difficulty.

When a country acquires a population of 100,000,000 people, the forest primeval which existed when it was settled has to disappear. It is all very well to bemoan the fact that if the black walnut which once covered the state of Ohio had not been destroyed and was sold as lumber at the present market rates, it would equal the assessed valuation of the property of the state, but there have now been created the cities of Cleveland and Cincinnati, whose people can not live on black walnut alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and the same is true of the forests in other sections of the country. The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest cul-

ture, and only a limited reforestation, then, is possible.

The effect of forests on rainfall in Europe has been carefully investigated and the records at many European localities, where the rain has been recorded for long periods, fail to show any tendency to a pronounced change of fall in recent years.

Study on Merrimack River

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. The best existing data in this country of which I am aware are those for the Merrimack River, on which a daily record of the stage of the river has been observed since 1849, on a gauge established below the dam at Lawrence, Massachusetts. An exhaustive study of this stream was made about 12 years ago by Col. Edward Burr, C. E., and a report submitted by him which is published as a government document. Colonel Burr's conclusions as summarized for the basin of the Merrimack River were as follows:

"Deforestation of the basin continued progressively from the early settlements until about 1860-1870, and since that period forested areas have increased through natural causes by 25 per cent or more of the entire basin, notwithstanding the continuance of lumbering operations.

"There has been no decrease in precipitation in the basin as a result of deforestation or any increase with the reforestation of 25 per cent or more of its area. The precipitation for 50 to 90 years at points within the basin or within a few miles of its borders shows tendencies, or cycles, that bear no relation to the change in forest areas.

"The average run-off through the river varies with the precipitation over its basin, and the percentage of run-off to precipitation is not appreciably affected by forest changes as great as 25 per cent or more of the basin. The frequency of floods has not been decreased by reforestation or increased by deforestation.

"Exceptionally high floods have occurred at intervals without respect to forest conditions. Flood heights have not been decreased by forestation or increased by deforestation, and the principal characteristics of floods are unaffected by forest changes. The duration of flood stages and the amount of run off during such stages have not been affected adversely by deforestation or beneficially by reforestation.

"Deforestation has not lessened the height of the river at low water or increased the duration of low-water periods, and the reforestation of 25 per cent or more of the basin has not had any beneficial effect on low stages of the river.

"Variations in stream flow are determined essentially by variations in climatic conditions which move in irregular cycles independent of forest changes. Correct deductions as to climatic variations and as to varying conditions of stream flow may be expected only from the analysis of satisfactory records covering periods of 60 years or more, and conclusions drawn from records extending through 40 years or less may, and probably will, be misleading or incorrect."

Reforestation and the Mississippi Floods

The greatest flood of the Mississippi at St. Louis occurred in 1844; the next largest in 1875. On the Great Lakes the high water of 1838 is the greatest on record. On the Ohio, the flood of 1884 exceeded that of 1913 at Cincinnati; and that of 1832, while 5 ft. lower at Cincinnati, was 5 ft. higher at Pittsburgh than the 1913 flood. The gauge records at the bridges over the upper Mississippi which cover a period of 30 years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusion of the European forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

It is argued by some that if the floods were occasionally high, they would not be as frequent with reforestation. Again let us search the records of the past. It is hopeless to expect to reproduce by reforestation the forest growth that existed at the close of the Civil War. Yet, from 1857 to 1867, the Mississippi Valley was visited by a most remarkable series of great floods. These floods occurred as frequently as any that have been recorded since that time.

It requires from 20 to 50 years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We are more vitally interested in the height that a river will attain in the next few months

than in what will occur in the year 2022 or 2072.

Reforestation as a means of reducing flood heights on the Mississippi River, for example, requires the conversion of too much farm land into a wilderness to be practicable. The waste land that can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

Reservoirs

Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the Great Lakes a practical illustration of flood restraint by means of natural reservoirs. Reservoir control of the Mississippi River was discussed by Humphreys and Abbot in 1858, and on the upper Mississippi the Corps of Engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country. These reservoirs have been most successful, not only for increasing the low-water discharge of the Mississippi River above St. Paul, the purpose for which they were constructed, but also for reducing floods in that portion of the river.

There is nothing novel in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low-water discharge at St. Paul and markedly reduce flood heights, yet 100 miles farther down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefitted or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

Reservoir Problem on the Mississippi

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Illinois, having an area of 7,000 square miles, slightly less than that of the state of Massachusetts, and a depth of about 15 ft., assuming that it would be empty when the river attained a bankfull stage.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouth of the tributaries to the headwaters, their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. If the prevailing winds in the early spring are from the Southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the South, reservoirs will be required on the streams of Ohio, Indiana and Illinois; a slight varying of the wind will produce a flood in the upper Mississippi while, if it blows from the Southeast, the principal sources of trouble will be the Red, the Arkansas and Missouri Rivers. To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The 1913 flood affords data for determining the effect of such a system of reservoirs. When, on April 2, 1913, the gauge at Cairo attained a height of 54 feet, there was flowing down the Mississippi River at least 2,000,000 cu. ft. of water per second. It requires about 11 days for a flood wave to be transmitted the 966 miles between Pittsburgh and Cairo. On March 22, the Pittsburgh gauge read 5.3 ft., which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In 10 days a flood travels the 858 miles between St. Paul and Cairo. On March 2, the reading of the St. Paul Gauge was 0.5 ft., corresponding to a discharge of the Mississippi of about 2,500 second-feet. In 8 days the effect of a flood at St. Joseph, Missouri, is felt at Cairo. On March 25, the gauge at St. Joseph read minus 0.1 ft., representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St. Paul, and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharge by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2d of April came principally from the White and Wabash and the lower tributaries of the Ohio, and after the water of these rivers started to subside, the flood from Cincinnati, though increasing from 57 to 69 ft. on the Cincinnati gauge,

could increase flood heights at Cairo less than 1 ft. The flood of 30 ft. at Pittsburgh on March 28 produced its effect on the Cairo gauge on April 8. It prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars, and its effect on the flood height of the lower Mississippi could not possibly have exceeded 6 ins.

General Limitations on Reservoirs

Great floods do not arise from average conditions, but from exceptional conditions such as are caused by heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir, to be effective, must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the flood crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality they necessarily prolong the period during which the river remains at a high stage.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power, and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water, as a rule only the excess can be used for power development. In the case of the new San Francisco water supply, now under construction, a large amount of power will be developed, but in this case the main storage reservoir is over 4,000 ft. above the city and the topography is such that at one point the supply line drops about 1,300 ft., and at another point it drops 1,000 ft. in a nearly vertical line, giving an excellent opportunity for a power development at a minimum expense and without interfering with the main object of the construction. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs, both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have occurred in the past.

Levees

Levees, properly located and constructed, are an effective means of protection against floods. Levees have been used for many years on the European rivers and to a great extent for the protection of the lands bordering the Mississippi River. At the present time there are 1,779 miles of effective levees in place between Rock Island, Illinois, and the mouth of the Mississippi. These levees contain about 400,421,000 cu. yds. of material. The levee system protects about 27,628 square miles of land. At the present time, the question of providing additional outlets or spillways on the lower Mississippi is being given great consideration. That the spillway will cause a temporary lowering of the flood water is beyond question, but it is not quite so certain that the ultimate effect of a spillway will be beneficial to the Mississippi, for there is a possibility that the abstraction of the water will cause shoaling of the channel below the spillway, which may produce serious results in time. Levees combined with channel enlargement and spillways are being used in the flood control of the Sacramento River. The spillways, however, are of secondary importance, the main dependence being placed upon levees and the straightening and enlarging of the channel of the river near its mouth, so as to afford a freer escape of the flood waters.

In locating levees, care must be exercised not to place them so near the banks of the river as to unduly crowd the stream and reduce the cross-sectional area sufficiently to prevent the escape of flood waters without causing their rise to such a height that they will overtop the levees. The great tendency is for the owners of the land on each side of the stream to crowd the levee as close to the bank of the stream as possible, leaving too little space for the escape of flood waters, with disastrous results to both sides.

The foregoing matter is from an address before the American Association for the Advancement of Science.

NOTES ON WATER SUPPLY SERVICE AT CHARLESTON, SOUTH CAROLINA

By J. E. Gibson, Manager and Engineer, Water Department, 14 George St., Charleston, S. C.

There is no branch of municipal service that receives greater condemnation in cases of failure to function adequately or properly than the water works. The slightest tendency of the water to be off color, off taste or otherwise lacking in quality or quantity, raises a storm of protest from the consumers, and the presentation of a bill that is higher than is usual or expected, will raise protestations that echo long after the rendering of and settlement of the bill.

Generally speaking, when we desire a commodity we buy without regard to the cost or value of the article itself. We all love to pamper ourselves, but the moment a service or commodity becomes a necessity, we take a niggardly attitude toward the party furnishing the service and all thought is lost of equity or justice in respect to the amount to be paid for the service rendered or for the commodity itself. Particularly is this so when the commodity enters into our daily life, such as gas, electric light and water supply service.

The Water Supply

The City of Charleston, acting in its legal capacity, caused to be dammed what was formerly a tidal salt water stream, thereby creating a large storage reservoir. The land area flooded by this reservoir exceeds three square miles, and in addition thereto, there have been purchased or perpetually leased, 5,000 acres of land to protect this reservoir from pollution. The inflow of fresh water soon displaced the original impounded salt water so that we now have approximately 3,000,000,000 gals. of fresh water in storage. The 42 square miles of drainage gathering area tributary to this reservoir is heavily wooded with pine, cypress, gum and similar growth in the swamps bordering the main stream and branches, and the water leaches out the coloring matter from the roots of the trees and the deciduous leaves of this wooded area so that the impounded water has a high color and is known as a peaty or colored water.

Generally speaking these waters carry no turbidity and are unusually free from contamination, the trouble, however, is to remove the coloring matter so that the water may meet the aesthetic approval of the consumer and be a satisfactory supply for household and manufacturing purposes.

To remove this organic coloring matter from the water it is necessary to treat it with sulphate of alumina, then pump it to large sedimentation basins where the coagulated coloring matter is allowed to settle out. The water is next filtered through modern type concrete filters where the remaining coagulated matter and pathogenic bacteria are filtered out, after which it is treated with sodium hydroxide to restore the alkalinity and soften the water for household, laundry and manufacturing use, and, finally it is sterilized with liquid chlorine that it may be absolutely free of pathogenic germs should by chance any have passed the filters. The water is then pumped into the mains for the use of the consumer. The service is maintained to all intents and purposes 100% of the time, in fact, should the service fail for a few hours only, many activities of our city would cease to function, street railway, gas, electric light, laundries, hospitals, sewerage systems, household operations and the Fire Department would be entirely helpless.

Fortunately for us there are a few cases where the water supply systems of our complex and congested life centers have failed. Drought is the most usual cause of curtailment of supply, and the cities of North Carolina and Pennsylvania have just recently passed through such a condition, due principally to the short sighted policy of the governing powers in denying the water departments the necessary funds and credits to extend their works and increase their water supply resources.

Occasionally we learn of the failure of a city's water supply due to the breaking down of the pumping machinery or the failure of the main supply lines. Such an instance occurred to the main conduit supplying the city of Montreal, Quebec, several years ago and a like occurrence to the new 250-mile water supply conduit of the city of Los Angeles, Cal., shortly after its completion. Our neighboring city of Greensboro, N. C., was subject to a similar occurrence last spring, and for a number of days water had to be hauled in tank wagons and distributed to the

citizens. The losses caused to the community by such failures cannot be reckoned in dollars. We spend large sums of money for highway improvements, autos, carriages, boats, travel, sports, entertainment and pleasure, but as above stated become niggardly, stingy and grasping when the essential commodity, water, has to be procured and paid for. What more essential commodity enters into our daily life than water and how willing we should be to pay for such service, when it serves us so faithfully as food, drink, laundry, the extinguishment of fires and last, but by no means least, as a vehicle for the removal of body and household wastes. We have expressed some of the foregoing statements in rather forceful language and it is not intended as a criticism or complaint on our part but only in an effort to drive home the necessity and importance of the water supply to our citizens.

Rate Making

When public water supplies were first introduced, the rate or amount to be paid by each property or household was assessed at a flat rate or charge in an effort to divide up the cost of the operation and maintenance of the water works plant among those using the service.

This flat rate is a heritage of the early pioneers and was probably first introduced by Appius Claudius in Rome. There were no modern plumbing appliances as we know them today, and therefore the use of water was confined principally to the ordinary household uses of cooking and washing. This flat rate system winks at the extravagance and wastefulness of the individual at the expense of the public. It is admittedly inequitable, conducive to wasteful habits and poor plumbing. The rate is made higher or in excess of the legitimate amount in an effort to cover these abuses. This form of rate today is frowned upon by all water works men, utility commissions and the courts.

Rate making has received more attention in the last 15 years than in all previous history of the water works business. In fact, it received very little attention until the introduction of the modern water meter. There are today three general forms of rates for metered water, they are:

1. The flat or uniform rate system where the water is charged for at a stipulated price without regard to quantity used or service rendered.

2. A minimum demand rate and sliding scale for water used in excess of minimum.

3. A service and demand charge rate with sliding scales for water used.

The objection to the first form, the flat or uniform charge, is that it does not distribute the burden equitably upon the consumers. It permits a property to obtain valuable service and puts a premium upon the penurious use of water.

The privilege of having a connection and being able to obtain water from a public supply on demand is valuable and should be paid for. The cost of reading meters, recording the same and rendering bills is a substantial cost and is practically uniform without regard to the size of the meter or the quantity of water taken. Further, there is no demand charge included in this form of rate, and certainly the water works is entitled to payment based upon the capacity of the consumer to demand service. As an example: A small manufacturing concern, such as a laundry requiring the delivery of large quantities of water in a limited time, must have a larger meter than a house. This class of consumer draws only for a few minutes at a time, nevertheless, requires a greater capacity of pumping machinery, filters and mains to meet this demand. The 2-inch meter on the supply to the laundry has the capacity of twenty ⅝-in. house meters, and therefore, equitably, it should pay 20 times the demand charge of the house.

The third schedule is the most scientific, in that it successfully divides the service rendered into the proper divisions:

1. The cost of reading the meters, recording, billing and accounting.

2. It places a demand charge on each consumer in proportion to his ability to demand water, and

3. It places a charge upon the consumer for the quantity of water taken, in accordance with a sliding scale based upon the actual quantity of water used.

Upon the granting of the franchise to the Water Company in 1903, the schedule was that of the old flat rate system, which was based upon a quarterly rendition of bills in advance of the service; that is, at the beginning of each quarter the consumer was billed for the water rate for the ensuing quarter based upon the number of fixtures, frontage and size of house. Very little or no complaint was made to the advance payment of the quarterly charge. Contracts were sup-

posed to be made for an entire year, and it was expected that the consumer would take water for twelve months.

There was a clause in the franchise which permitted a consumer on demand to purchase a meter and take water by meter rates, which were also prescribed, based upon the daily consumption in thousand gallons. A like privilege was granted the Water Company, in that if they suspected a party of wasting water, having poor plumbing or using it for other purposes than that contracted for, they had the privilege of installing a meter and charging for water at meter rates. The result of this schedule was that those people who were thoughtful, soon realized that they were taxed an excess amount to cover possible wastage and loss, and began to demand meters, more particularly the commercial concerns. At first there were few meters in use, and it was a simple matter for one man to go out and read these meters on the first of each month.

With large consumers of water such as railroad companies, with the possibility of stoppage of meters involving large pecuniary losses and causing argument as to the proper adjustment of bills, the practice of reading meters monthly was justified and is still followed.

This was the condition of affairs when the Commission took over the operation of the plant at the time of purchase by the City in 1917.

Abuses had grown up during these years of private ownership due to political conditions. Sixty per cent of the consumers were obtaining water through meters, some having yearly contracts, others monthly contracts. Those having yearly contracts were granted the privilege of offsetting high consumption during one period of the year against low consumption at another period. Those having monthly contracts were denied this privilege, which caused friction and discontent. The remaining 40 per cent of the consumers were being supplied under the old flat rate system of contract.

An analysis of the total water pumped and delivered to the distribution system and a systematic reading of the small meter supplying the metered consumers, showed that the 40 per cent of unmetered consumers were using over 60 per cent of the total water pumped. A census of the city, of the number of dwellings therein, showed that there were approximately 12,000 properties that should be consumers of water and of these 12,000 there were existing on the books only 6,500 consumers of water. How and where did the remaining 5,500 properties get their water supply? There were two sources, wells and cisterns which had been condemned by the Health Department as insanitary and likely to cause sickness and epidemics, and secondly, a surreptitious taking of water through the taps of neighboring properties. A large percentage of these properties not connected to the water works system were owned or at least occupied by the colored population.

The question of municipal ownership and operation was a doubtful experiment, and in my opinion our Commission wisely decided to disturb the customs and rates in force to the least possible extent, and therefore adopted our present schedule of rates. These, while not the most scientific, are equitable and just.

1. We discarded the yearly contract, feeling that it was not equitable, and if required, and not enforced, would grow into an abuse.

2. That a three months' contract was equitable and imposed no grievous hardship, should circumstances compel one to surrender his contract after a few weeks of service, as the minimum charge of $3 would not more than cover the cost of setting meter, removing same, reading and billing for a short period.

3. It would permit those people who spend the summers away from the city to close their houses, cancel their contracts and have the water shut off, thus eliminating the danger of high bills due to leaky plumbing during their absence. It further gave them the possibility of equalizing the low consumption during one month as against high consumption during another month of the same quarter.

The minimum rates provide an ample supply of water to cover all legitimate needs of the average family without offering a premium on a parsimonious use of this essential commodity. In other words, it is possible for the average family in the city of Charleston to have all the conveniences of modern plumbing, such as kitchen sink, toilet, bath room, basins and an ample supply of water for $3 a quarter; further, it places this service within the reach of the most humble citizen.

That this action on the part of the Commission was wise is evidenced from the satisfaction it has afforded. Consumers have increased from a little over 6,500

to over 9,000 in the five years of municipal ownership. The entire city has been metered, the amount of water accounted for has increased from 55% in 1917 to an average of 85% in 1921-1922. The difference is accounted for by the water used for municipal sewer flushing and fire purposes. This percentage of accounted for water is above the average of American cities, and is exceeded by a few only.

A Study of Monthly Reading and Billing

The only complaint that has been made against the schedule as adopted is the payment of high bills owing to defective or poor plumbing, and some of our citizens feel that if the Water Department should read meters and bill monthly, they could thereby check up and keep tab on the condition of their plumbing more accurately than if read quarterly.

A careful study of water bills justifies the sub-conscious deduction of our employees, that consumers pay little attention to their increasing water bills until they reach a very high percentage of the normal consumption, and even then do not take the necessary precaution to see that their plumbing is properly repaired, as is evidenced by a second and third period of abnormal consumption.

How much less attention will be paid to the increasing consumption when the readings are made monthly, and the increased increments therefore smaller? Further, a leak amounting to so little as 1 gal. per minute taking place in a yard toilet (usually installed for the convenience of servants, and therefore not directly under the observation of the thoughtful members of the family), will account for a bill of $10.50 in 30 days.

Using the information obtained in the study of bills, and assuming that $10 is a reasonable and not an exorbitant bill and that the arithmetical mean of these divisions represents the average amount of money involved in each bill, we find that the following bills were rendered in excess of $10 per quarter:

2,983	Bills rendered for	avg. amt. of	$12.50			
961	Bills rendered for	avg. amt. of	17.50			
382	Bills rendered for	avg. amt. of	22.50			
375	Bills rendered for	avg. amt. of	37.50			
64	Bills rend. not in excess of	amt. of	75.00			

Using the limit of a non-exorbitant bill as $10 per quarter, and the information on heavy consumption, together with the possibility of a small leak, as hereinbefore mentioned, it is a reasonable and fair conclusion that there would be no saving effected to consumers where their bills are only 150% in excess of $10 or $15 per quarter.

Again, assuming that every dollar in excess of this maximum bill of $15 could have been saved the consumer, we find the following:

2,983	Bills at an average of	$12.50	less	$15.00	max.	No saving.	No saving.
961	Bills at an average of	17.50	less	15.00	max.	Saving $ 2.50	$ 2402.50
382	Bills at an average of	22.50	less	15.00	max.	Saving 7.50	2865.00
375	Bills at an average of	37.50	less	15.00	max.	Saving 22.50	8437.50
64	Bills at an average of	75.00	less	15.00	max.	Saving 60.00	3840.00

A total saving during the three years and nine months of $17,545.00
An average annual saving of $ 4,690.00

The above assumptions are certainly liberal and I feel that practically they cannot be obtained, owing to the frailties of human nature, and knowing how soon we lose sight of the newness of the "broom." However, the consumer is fully entitled to the benefit of the doubt in the case.

The next phase of the subject is, how much will it cost all of the consumers to effect this saving to one and fifty-four hundredths per cent of the consumer? Before proceeding to this portion of the discussion, let us consider some of the duties of the Commission to the public.

It is undoubtedly the duty of the Commission to operate the Water Works Plant efficiently:

1. As to the quality of the water.
(a) For drinking and cooking purposes.
(b) For laundry and general household use.
(c) For manufacturing purposes.
2. As to quantity of water.
(a) For sanitary purposes.
(b) For fire protection.
3. As to extension of mains and conduits and plant to supply the growing needs of the city, (for without an adequate water supply no city can grow, however fortunately she may be otherwise situated and endowed).
4. Economically upon a business basis.
(a) That the citizens may be taxed equitably and justly for the service rendered them and that none receive privileges not enjoyed by all.
(b) That all moneys due be collected promptly and all purchases of material and supplies be honestly made at lowest obtainable prices, quality alone for service intended being considered.

(c) That all expenses of operation, maintenance, sinking fund, interest on bonded indebtedness or cost of plant be paid from the income collected and that any excess income above these expenses be set aside as a surplus out of which future extensions, improvements to plant and water supply facilities shall be made.

(d) To employ an efficient personnel to conduct the operations of the business with the least number of persons that there may be a minimum of inefficiency, soldiering, slackness and indifference.

It is well recognized that the most efficient organization is the one having the smallest personnel to accomplish the work with accuracy and dispatch. With our present system of quarterly reading, the work has been so systematized that each employee has a definite portion of the work to perform, and each is thoroughly acquainted with the work of the other members of the organization, with the result that there is thorough team work. There is a minimum number of units in each division of the work, and, therefore, the responsibility for error can be placed directly upon the one at fault. This has resulted in a very high degree of efficiency, and it will be necessary if monthly reading of meters is adopted, to increase the number of employees, with the consequent and inevitable loss in efficiency due to increased number.

Should we adopt monthly reading of meters, we estimate that it will require the following additional employees:

An assistant to the Contract and New Business Clerk,

Three additional Meter Readers,

Three additional Clerks in the Accounting Department,

One additional man for shutting off and turning on water.

Further, stationery supplies such as bill heads, delinquent notices, etc., will be increased three-fold.

The cost of postage for the delivery of bills will be increased three-fold.

The general expense in the office for ledger cards, addressograph plates and inter-department stationery will be increased three-fold; and to accomplish the work with the increased force, it will be necessary to install an a ddditional mechanical book-keeping machine.

We estimate the increased cost of this additional help and equipment as shown in the tabulation below.

It will be seen, therefore, that to effect a saving of $4,700 per annum to one and one-half per cent of our consumers, it will be necessary that all of the consumers spend a total of $12,540 per annum. Certainly an inefficient method of saving.

Of course, it will be argued by some, that as the Department is earning money in excess of its operating expenses, maintenance, depreciation and sinking fund, and as the property is owned by the public, this additional cost of reading meters monthly should not be considered. We contend that this is a false premise, and that it is the duty of the Commission to operate the plant efficiently for all, and that if 98½ per cent of the people are taxed a sum ever so small for the benefit of the 1½ per cent, then some are receiving special consideration.

The Department is endeavoring to help all consumers and to this extent reading meters and inspecting premises to aid and assist the consumers in locating their troubles. This service, however, instead of proving beneficial to the consumer, seems to be leading in an opposite direction in that requests for the re-reading of meters and inspection of premises for leaks are increasing, and further, some of the consumers seem to think that it is one of the duties of the Water Department to locate defective plumbing, and unless the Department can locate the cause of the high consumption of water, they take the position that it is the fault of the Department and they should be relieved of the excessive bill.

A record of the re-reading of meters during the past four months shows that 10% of the meters regularly read have been re-read on request of the consumer, and in addition thereto, over 400 inspections were made at the request of property holders to determine whether their

Item	Increased Cost
An Assistant to Contract and New Business Clerk	$ 150.00
Three additional Meter Readers	375.00
Three additional Clerks	220.00
Additional man for shutting off and turning on water	70.00
Stationery—additional bills	30.00
Postage—delivery of bills	120.00
Other stationery	65.00
Maintenance and depreciation of second billing machine	15.00
Increased cost per month	$1,045.00
Annual increased cost	$12,540.00

plumbing was leaking. This re-reading and inspection service is likely to become an abuse in that property holders do not take the ordinary precaution to watch the services and fixtures themselves.

The plumbing and fixtures of a house are a part of the consumer's property and should be taken care of and watched by him the same as any of the other manifold household operations. If care and prudence are not exercised the fixtures become a "thief in the night," or the same as a careless and wasteful servant.

The meter is a comparatively simple device and as installed is readily accessible and easily read, and an inspection of the meter by the householder will readily determine whether leaks exist. Upon the development of a leak the remedy is to employ a plumber to repair the plumbing and after he has done his work it is a very simple matter to test out the thoroughness of his work by watching the meter for a few moments when no water is being drawn from any of the fixtures.

The matter of leaking fixtures and service pipes was aptly expressed by our mayor in his address to our aldermen as follows: "The duty, therefore, is put up to the individual to watch his fixtures and see that there are no leaks, just as the individual is supposed to do wtih his health."

In an effort to determine the custom as to meter reading interval, a questionnaire was mailed to 32 cities located in the southeastern portion of the United States and replies were received from 21 including ourselves. Similar information was obtained and tabulated from the annual reports of 12 northern cities.

It was shown from the information received from the southern cities that monthly and quarterly reading of meters are about equally divided, a slight preponderance are at present using monthly readings. Some of the managers who are now reading monthly prefer quarterly reading and some who are now reading quarterly, prefer monthly reading. The northern cities seem to prefer quarterly reading almost unanimously. One city reads semi-annually and bills annually.

We are very much of the opinion that the question of reading meters, as adopted by any community, is more one of custom than otherwise, but where the matter has been gone into with a view of obtaining the most economical operation of the entire system that the reading of meters oftener than quarterly is inefficient and expensive.

In summarizing the arguments for and against monthly reading and billing we have:

Argument in Favor of Monthly Reading

1. Possibility of an estimated saving of $4,700 per annum to consumers.
2. Possibility of catching a leak before the amount of the bill has reached an exorbitant or excessive charge.
3. The possibility of enabling an individual property holder to check up on the condition of his plumbing.

Argument Against Monthly Reading

1. Increased cost to the department of $12,500 per annum.
2. The above expenditure protects less than 2 per cent of the whole at the expense of all.
3. Increased number of employees and office force with lowered efficiency.
4. Increased probability of error, with increased number of requests and complaints from consumers for re-reading.
5. Increased complaints as to frequency of bills and requests that bills be sent not oftener than once a quarter, causing confusion in office routine.
6. Increased complaints of consumers on account of receipt of delinquent notices and the shutting off of water in case of nonpayment of bills.
7. Increase in complaints due to the short period which consumers will have to average up their high or peak consumption. (With quarterly readings, we now have a number of requests that consumers be allowed to make up their excess bills accruing one quarter with deficiencies of the past quarter.)
8. Will necessitate a revision of our rules and regulations which have been fairly well established and understood during the past five years of operation.
9. Reduces the credit extended consumers. (At present a consumer has an average credit of approximately 60 days, whereas with monthly reading this would have to be abolished and bills would necessarily have to be paid not later than the 15th of each month.)
10. Would be a change of custom without a definite assurance of any improvement.

That the quarterly reading of meters and billing for water used has met the requirements of efficient management goes without saying, as is evidenced by the five years of successful operation at Charleston. We passed through the trying time of the world war without an

increase in rates for water service when many other water departments throughout the country were forced to raise their rates and issue bonds for increased facilities. We have not only met all of these conditions, but also have brought the plant from a run-down, inefficient condition to a state of high efficiency, making many necessary and permanent improvements, so that today we have a water works system in which every citizen can take pride.

We are not averse to changes if they show a possibility of improvement. We are, however, firm believers in conservatism, especially in the matter of the municipal operation of a water works system, and feel that the public should rely upon the business ability and good judgment of their commission as to the best business policy and the management of the water department.

The foregoing matter is from a paper presented by Mr. Gibson before the recent convention of the Tri-State Water and Light Association at Birmingham, Ala.

PRACTICAL RANGES IN LOAD FACTORS FOR WATER PURIFICATION PLANTS

(Editor's Note—Following is the full text of the report of the Committee of the American Water Works Association on Practical Ranges in Load Factors for Purification Plants. Mr. Edward E. Wall, Water Commissioner of the city of St. Louis, Mo., was chairman of the committee.)

In May, 1921, a questionnaire was sent out to a large number of filter plants throughout the country by the members of the committee, which brought to them a great quantity of information, most of which, however, was of little value for the purposes of the committee, on account of the great majority of plants being operated under average conditions and treating waters not relatively high in pollution. The data collected from each plant showed so much variation from time to time because of prevailing conditions (e. g., the variations in quality of the raw water, such as turbidity, fineness of suspended matter, color, hardness, temperature and bacterial content, quantity of water treated, length of time for coagulation and sedimentation, rate of filtration, etc.), that it seemed an interminable and hopeless task to attempt to determine limits for purification modified by minimum or maximum requirements of these numerous variables. It was the intention of the committee to select from the list of plants answering the questionnaire, those operated by experienced men, and dealing with raw waters having rather a wide range in their objectionable qualities, for close observation and study.

This did not prove to be entirely practicable when the information received from numerous places was tabulated, because of the great variation in the character of purification plants, the diversity of the methods used and the degree of skill exercised in their operation, not to mention the wide range in the characteristics of the waters treated, so that the selection of distinctive plants was not so easy as had been at first imagined.

To illustrate this, and also to give an idea of the ranges in the qualities of the raw waters and the variations in treatment and operation, Table I, summarizing results, has been prepared.

An examination of the individual reports reveals the fact that many plants deal with raw water varying in one or more of the objectionable characteristics from the maximum to the minimum shown in the table, and are reported as obtaining satisfactory results. This may be interpreted as meaning that the consumers in those localities, having always been accustomed to the local water supply, have become resigned to it, believing that no further improvement is necessary or can be made. The committee has no way of finding out where this is the case, as only at a few places are complete and thorough analyses made frequently enough to supply the information necessary to establish the real quality of the water supplied to these communities.

The figures set out in the table give but an imperfect idea of the difficulty of attempting to classify purification plants according to the quality of the raw water treated. Leaving out of consideration the wide variance in methods of treatment, there still remains for study the great difference between the surface waters east of the Alleghanies and those of the Mississippi river valley, as well as the variations in the individual waters of any district of considerable area.

Illinois

For example, of the 19 plants in Illinois summarized in the table, none of them take their supply from Lake Michigan, but from streams, the waters of which would naturally be supposed to be very similar in character. Now, as to the

loadings on these plants, the maximum turbidity reported at any one plant is 15,000; two plants report maxima of 10,000; one reports 8,000, and several 2,500. Two plants report average turbidities of about 500, two others from 250 to 300, and four from 100 to 150.

The maximum color reported is 250; two plants report 70, four give maxima of 50 and seven state their highest figures from 30 to 40. The highest average color reported is 54, two plants give averages of about 35, four others from 25 to 30, and five from 15 to 20.

The maximum bacterial count is 90,000, the next 50,000, three others report 18,000 to 24,000 and two plants 8,500. The highest average is 3,600, two plants have 2,100, two others 1,250 and 1,750, respectively, and four from 400 to 800.

Two places report gas-forming organisms present in all one-tenth c. c. samples of raw water, two others find positive results only in a majority of one-tenth c. c. samples. Eleven plants report that 10 c. c. samples of raw water always show positive results and that one c. c. sample in most cases also analyze as positive. Three places report nine-tenths, three others three-fourths, and four that one-half of the one-tenth c. c. samples show positive results.

All of these plants are reported to purify successfully these waters, which vary so greatly in their objectionable qualities, but it is likely also that there is just as great a variation in the quantities of chemicals used and in the wash water and chlorine necessary to produce safe effluents.

Information on the Illinois purification plants was supplied to the committee by Mr. Harry F. Ferguson, Chief Sanitary Engineer of the State Department of Public Health, who has very generously agreed to digest the present available analytical data along the lines decided upon by the committee and to arrange for additional and more complete analytical data in the future from plants dealing with highly polluted or difficult waters.

There are not many water purification plants in Missouri, and information has been received from only five places, at none of which is there any indication of overloading, nor do any of them deal with waters carrying a high degree of pollution. This is true of all the plants in several other states, for example, Iowa, Minnesota, Wisconsin, North and South Dakota, from which the committee has received data. Inquiries as to whether the communities in these states are satisfied with the water supplied them are invariably answered in the affirmative. Requests for health statistics on water-borne diseases have been barren of results, principally because no reliable records seem to be available. All of these plants seem to be operating without changes in the methods of treatment, year after year, so that apparently the raw water is not getting appreciably worse.

Virginia

There are 52 filtration plants in Virginia, of which one is of the slow sand type, and four are primarily for water softening. None of the raw waters treated are very badly polluted and the turbidities seldom exceed 2,000 or 3,000 and then only for short periods. Very little data is available as to what should be considered excessive loads for the several processes, such as coagulation basins, filters and sterilization. Practically all of them are being operated without serious difficulty and the loads on basins and filters are well within the range as to what should be considered permissible. Only eight of these plants have laboratory facilities at the works, and these may be classified with regard to the kind of water treated, as follows:

No.	Tot. Cap. m.g.d.	Classification.
3	48	Primarily for color removal. Bacterial pollution negligible.
1	6	Treating impounded supply slightly turbid at times. Bacterial pollution negligible.
2	8	Bacteria (37 deg. count) seldom above 1,000 per c. c. Turbidity usually below 600.
1	28	Bacterial (37 deg. count) from 500 to 3,000 per c. c. and turbidity usually below 1,000. Only partial laboratory data available.
1	30	Richmond plant, filtration contemplated.

TABLE I—DATA ON WATER PURIFICATION CONDITIONS AND PRACTICE.

State	No. of Plants	Type of Plant	Raw Water Turbidity Max.	Turbidity Min.	Color Max.	Color Min.	Bact. Per c.c. Max.	Bact. Per c.c. Min.	B-Colo Per 100 c.c. Average
Pennsylvania	6	Rapid Sand	6,000	2	500	5	17,000	5	15 to 1,000
New York	6	Rapid Sand	6,000	13	180	6	100,000	14	15 to 340
New Jersey	3	Rapid Sand	1,000	5	150	5	2,400	0	.....
Missouri	5	Rapid Sand	5,000	5	35	3	113,000	15	22 to 90
Illinois	19	Rapid Sand	15,000	5	250	8	90,000	40	20 to 520
Pennsylvania	5	Slow Sand	4,500	2	40	5	1,200,000	110	75
New York	3	Slow Sand	600	3	62	15	48,000	10	1,000 to 13,000

From studies on the above plants, and also observations at the smaller plants, Mr. Richard Messer, Chief Engineer of the State Board of Health of Virginia, and a member of this committee, draws the following tentative conclusions:

Coagulation Basins—(a) For colored waters the period should be at least 6 hours and preferably longer, up to 10 or 12 hours.

(b) For turbid waters the period should be at least 3 hours. However, a longer period serves as an extra safeguard at times of sudden fluctuations in the character of the raw water.

(c) The velocity of flow through the basin should not exceed 0.75 ft. per minute and in the last half of the basin the velocity of not over 0.4 ft. per minute is desirable.

Coagulation—Regulation of the application of chemicals to obtain the optimum coagulation is a matter of prime importance. When the optimum coagulation is obtained the floc which goes into the filters will be of such quality as to maintain maximum efficiency of the filtration process, provided the floc is not broken up while being conveyed from the basin to the filters. If the application of chemicals is not correct the suspended matter carried onto the filters will be of such a character as to penetrate deep into the sand and eventually pass all the way through. Except as to the amount of wash water required it does not make so much difference as to the quantity of floc carried onto the filters but the quality is of prime importance.

Filter Sand—For filtering waters in this state, the sand should have an effective size of between 0.35 and 0.45 mm. and a uniformity coefficient of not greater than 1.6. Not more than 10 per cent by weight shall be coarser than 0.9 mm.

Filter Gravel—The depth of gravel shall be not less than 18 ins. and preferably 20 to 21 ins. The gravel shall be graded and placed carefully and the thickness of layers shall vary directly as the size; i. e. the greatest depth to consist of the 2½ to 1 in. size and the thickness of layers decreasing up to the surface layer.

Washing—For effective washing the rise should not be less than 18 ins. per minute and preferably 24 ins. per minute, but not greater. It is very important that the rate shall be uniform over the entire bed.

Chlorination—Provision should always be made for sterilizing the filtered effluent with chlorine as a secondary safeguard.

In some instances chlorination alone may be relied upon, provided the supply to be treated is practically free from turbidity at all times and provided further, that the sanitary survey shows that there is only a remote possibility of sewage getting into the supply but where the origin of the B. Coli content cannot be ascertained.

Northeastern States

The waters treated in the northeastern states, Pennsylvania, New York, New Jersey, etc., are in many cases highly polluted, so that it is a far more promising field for study for the purposes of this committee than can be found in the southern and western states.

Mr. S. M. Van Loan, Deputy Director of the Bureau of Water in Philadelphia and a member of this committee, has collected a mass of data from these states, but like the other members of the committee, has met with great difficulty in obtaining precise and definite information on points of special interest to supplement data given in the first reports. In many cases members of the committee have been greatly disappointed in receiving no replies at all to questionnaires sent out, and especially from plants known to be treating difficult waters.

Mr. Van Loan goes on to say that due recognition is given to the fact that at certain plants, methods of keeping records are widely different and a questionnaire might not at all times adapt itself for furnishing the information desired. Also, that one feature that has injected a degree of uncertainty in analyzing plant results is the method used in determining bacteria counts, and until the Council

TABLE I—CONTINUED.

Treatment of Water Before Filtration.	Rate of Filtration Per Acre	Time in Hours Bet. Washings	Chemicals Used.
Aeration, Coag. & Sed.	80 to 176	3 to 50	Alum, Iron, Soda Ash & Chlor
Coagulation & Sedimentation	120 to 181	4 to 24	Alum, Chlorine & Cop. Sulp.
Coagulation & Sedimentation	62 to 200	8 to 60	Alum
Coagulation & Sedimentation	62 to 125	10 to 171	Alum, Lime & Iron
Aeration, Coag. & Sed.	50 to 175	6 to 72	Alum, Lime & Soda Ash
Sed., Aeration & Pre-filtration	2 to 10	.....	Alum, Lime & Chlorine
Coag., Sed. & Prefiltration	3	.....	Alum & Chlorine

on Standardization has set a standard, which will be used generally throughout the country, there can be no consistent comparison made on the various plant results. He suggests that a standard form for reporting filter operation should be adopted.

Ohio

Following his appointment on the Committee of the American Water Works Association on Practicable Loadings for Purification Processes in 1920, Mr. F. H. Waring, Principal Assistant Engineer, Ohio State Department of Health, organized the Ohio Conference on Water Purification in November, 1921, comprising the men actually employed in charge of water purification plant operation in the state of Ohio. Ohio has 62 water purification plants serving 32 cities, 23 villages and 7 unincorporated communities. The total population thus served is 2,561,000 as of the 1920 census. A practically complete representation was obtained at meetings held in Columbus in November, 1921, and November, 1922.

At the 1921 meeting questions were put to the Ohio filter plant superintendents, these questions involving research study upon loading of water purification processes. The writer selected 10 filter plants for conducting of the special studies. The selection was based on an accurate knowledge of the peculiarities of the water purification plant, the raw water, and the fact that these plants were in charge of experts trained and experienced in water purification and control. The variety of conditions encountered is indicated as follows: Akron, a 30 million gallon plant taking water from a large impounding reservoir on Cuyahoga River; Cincinnati, a 112 million gallon plant taking water from Ohio River directly; Cleveland, a 150 million gallon plant taking water from Lake Erie; Ironton, a 4 million gallon plant taking water from Ohio River directly; Lima, an 8 million gallon plant using as a source of supply a large artificial lake receiving intermittent pumpage from Ottawa River; Portsmouth, an 8 million gallon plant taking water from Ohio River directly; Sandusky, a 10 million gallon plant using as a source of supply Sandusky Bay of Lake Erie; Steubenville, a 6 million gallon plant using Ohio River as a source of supply; Toledo, a 56 million gallon plant using Maumee River as a source of supply; Warren, an 8 million gallon plant using Mahoning River as a source of supply. In addition to the above, three plants having water softening features were selected, Columbus, a 54 million gallon plant using a large impounded reservoir on Scioto River; Defiance, a 2 million gallon plant using Maumee River directly; Youngstown, a 28 million gallon plant using Mahoning River as a source of supply.

The foregoing selection served to cover the range of raw waters in this State varying from the least polluted and cleanest source of supply (Lake Erie at Cleveland) to the most intensely polluted and otherwise objectionable source of supply (Mahoning River at Youngstown).

In order to make comparisons of the several plants the 1921 conference standardized the procedure for reporting; for laboratory practice, and quality of the filter effluent both before and after chlorination. In several instances it was possible to utilize previous data collected, but for most plants work was initiated. The 1922 conference held at Columbus in November took up the topics assigned previously, each of the ten regular filter plants reporting upon the studies and each superintendent offering opinions in answer to the questions. Certain of the topics have been held over for further study and certain new questions were raised. The complete discussions of these topics and including original papers of great value prepared by some of the men are now being compiled for publication in a special bulletin of some 125 pages to be published by the Ohio State Department of Health.

There will be available for the committee the results of investigations into the stream flow, the pollution and the self-purification of the Illinois River, conducted by the U. S. Public Health Service, and of a similar investigation on the Kansas River and its tributaries conducted by the State Board of Health of Kansas, whose Chief Engineer, Mr. Albert H. Jewell, writes that on account of the mass of data to be digested, no information of value to the committee can be given at present.

Stream Pollution and Self-Purification.

The determination of the practicable loads for purification processes leads directly to consideration of the pollution of sources of water supplies and the self-purification of streams and impounded polluted water, so that study of these subjects must perforce become a part of the committee's work. Even if it were possible to develop the science of water purification to the point where water fit

for human consumption could be produced from the very worst polluted sources, the item of cost, if nothing else, would set a limit beyond which it would be impracticable to go,— that is, there would always be a point where the cost of treatment would mount up to such a figure that the prevention of pollution would be cheaper and more practicable than purification.

In this connection, Mr. H. W. Streeter, Sanitary Engineer of the U. S. Public Health Service, writes from Cincinnati:

"In connection with stream pollution investigations being conducted by the U. S. Public Health Service, consideration is being given to a proposed extension of a preliminary study of filter plant loading factors made by this service a few years ago, the results of which were briefly summarized in a paper, 'The Loading of Filter Plants,' appearing in the March, 1922, issue of the Journal of the American Water Works Association.

"Consideration has thus far been given to two possible lines of study of the problem, one consisting of a field survey of a selected group of plants in routine operation, and the other an experimental study of loading factors under controlled conditions, using for this purpose an experimental plant to be built for the purpose, somewhat similar to those which were recently operated at Milwaukee and Detroit, but located on the Ohio River at Cincinnati, which is our headquarters. We have thought of the latter kind of a study as permitting us to observe purification efficiencies under conditions approaching or even surpassing overload without incurring the dangers to water consumers such as would be the case if experiments of the kind were to be attempted at a regular plant.

"The experimental method would permit us, moreover, to adjust arbitrarily and measure accurately the various complex factors that modify purification efficiencies under different conditions; likewise to determine under controlled conditions whether any definite law underlies the reaction of water purification processes to different degrees of loading. Enlightened on these points, we could then test their generality by field survey data and greatly clarify the main objective to be sought in such a survey."

The committee is much interested in Mr. Streeter's project and will follow closely the establishment and work of this experimental plant, co-operating with him in every possible way.

Although it may seem that the committee has little to show for the work of almost two years of its existence, in truth a great deal of work has been done in collecting information, finding out what sort of facts can be obtained and used, in determining the general course of investigation, and obtaining assistance from and co-operation with individuals and with public and private organizations.

The committee has also come to a full realization of the formidable task before it, the many directions in which its inquiries must lead, and the great variety of perplexing problems resulting.

The individual members of the committee are, to a certain extent, working independently of each other, each one following largely his own ideas as to how information should be obtained and digested. Then each member will send to the chairman a statement of conditions and results as he finds them, together with his opinions and conclusions. The chairman will broadcast them to the rest of the committee and to such others as are assisting the committee, and will eventually combine all these reports into one general committee report.

As has been heretofore stated, satisfactory service to the people served, and vital statistics not below the average for such places, must be considered conclusive evidence that water purification there is efficient. The loads upon these plants, if unusual, may serve to mark the approach to limitations in general. Any plant may for a short time be taxed to the full extent of its capacity and require all the ingenuity of its superintendent and chemist, together with a liberal use of chemicals, to deliver a potable and safe water under these extreme conditions, but this load could hardly be taken as the limit for similar purification plants, for at least two reasons, first, because it is extremely improbable that any other plant could encounter even approximately the same conditions, and second, because the peak load under which the plant was able to stand up for a short time was an overload and beyond its working limit.

A general standard may be set for a safe water for domestic use, just as that established by the U. S. Treasury Department for waters used by common carriers, but any attempt to place a limit on color, hardness, taste, odor, etc., would seem to be futile, since those characteristics vary with localities, where each community sets up its own standards.

FUNCTION OF STREETS AND HIGHWAYS IN NATIONAL TRANSPORTATION

By J. Rowland Bibbins, Engineer, 921 Fifteenth St., N. W., Washington, D. C.

The following is not an attempt to present a finished analysis of the present complex transportation situation but rather to mobilize some outstanding facts which have an important bearing upon the development of a national transportation policy in which the various agencies can play their proportionate parts most efficiently. Certain conclusions are stated, however, for the purpose of concentrating discussion where it is most needed. It is worth noting that no organization or association, national or otherwise, has as yet given to the whole subject of transportation the well-balanced and detailed study which is most urgently needed to meet the oncoming demand for adequate transport facilities.

Recent literature is replete with pronouncements of a general nature, but the time has come for specific action and the most fundamental changes in the policy of various transport agencies have already begun. The time is ripe for concerted action based upon reasonable interpretation of facts before, rather than after, broad national policies are enunciated.

How fast we are moving is evidenced by the fact that the Transportation Act, 1920,—our bible—does not definitely visualize to the slightest extent the function of highways or highway transport in our future system, nor does it recognize that the function of transportation begins with the origin of shipment and ends at the final destination of a consignment, including land, rail, water, terminal, collection and delivery movement. Station to station movement by rail is only one part of the operation and represents, perhaps, only one-half of the total cost to the consuming public.

Even the Agricultural Inquiry of 1921, while revealing an immense body of new data regarding the inefficiencies of distribution, did not give an adequate picture of the need of correlating the various transportation functions, especially highways and waterways. Perhops the broader view was too new and too big to permit of any other treatment at the time.

The important thing now is to recognize where transportation inefficiency exists and move toward its correction. Otherwise the problem of keeping up with our tremendous transportation demand will become increasingly burdensome. The review of the problem, as herein presented, is purposely comprehensive in scope. It rests with the various national organizations and technical bodies to develop practical ways and means for perfecting facilities and operations at the various points in the transportation journey where this increased efficiency would insure the greatest improvement in transit with the least drain on the capital resources of the country.

Some Pertinent Transportation Facts Reasonably Well Established

1. *Cost*: Our second industry, next to agrgiculture. To build it has cost about 50 billions net; 2-5 equals railroads; 2-5 equals highways and highway transport; 1-5 equals balance: marine, waterways, port facilities and electric railways. Total equals 1,200 dollars per worker. Probably half railroad investment, or 10 billion, is in other than main line track—terminals largely.

2. *Growth*: Cost has doubled in a decade. Railroad cost doubled in 20 years. Highways, nearly four times in 20 years, last doubled in four years. Railroad cost increased proportional to square of population; all transportation nearly as the 5th power of population.

3. *Capitol Input*: About 23 billions last decade; 2.3 billion average, per year. Highway ,16 billions; railroads, 4 billions; ratio, 4.1. Previous decade, 1.4.

4. *Freight Traffic*: Basic railroad revenue tonnage has increased steadily and consistently since the Civil War, not far from the cube of population. City population in the per cent of total is increasing; hence terminal traffic and operations are increasing, probably faster than the cube. Trucking tonnage must bear about the same relation, for all railroad freight (except that which moves car load direct) passes over streets, roads and highways one or more times, according to number of fabrications involved. Ton mileage is increasing faster than the cube of the population, due to increasing length of average haul.

5. *Present Traffic Indications*: A new high record in 1922-23. Present traffic running ahead of all expectations, C. L. and L. C. L. and commodities, now loading nearly one million carloads per week, the previous high peak record.

6. *The Next Twenty Years*: Estimated

population of 130 million people. A revenue tonnage of nearly 4 billion tons and between 800 and 900 billion ton-miles must be provided for. At least 25 billion of new capital is needed for all transportation, assuming all growth is *only as fast* as railroads. Also an additional 25 billion for replacements of worn out property.

7. *Operating Cost to the Public*: Probably 15 billion at present or an addition to the family budget of 275 dollars per worker per year. Transport cost of hauling tonnage to and from rails, probably equal to cost of rail haul, i. e., 4.5 to 5 billion per year.

8. *Growth of Facilities*: Rail mileage is increasing about as fast as population; freight cars as fast as tonnage; locomotive tractive effort as fast as the ton mileage. Increase of capacity of standard surface freight facilities, station team tracks, docks and wharves, is about proportional to lineal feet of extensions; also streets and highways, either single or two level, only in proportion to number of additional traffic ways provided.

10. *Highway Transport*: Gross motor registration in U. S., now over 12 million, has doubled 10 times since 1900, last doubled in 4 years. Estimated that nearly 30 per cent of vehicles are on farms. One and one-third millions trucks with rated capacity of 1 2-3 million tons. Estimated they carry nearly as much tonnage as the railroads with their 100 million tons car capacity. Connecticut road tests report 32 per cent of passengers carried for business purposes; motor production now maximum, 346,000 cars for March, 1923, over 2½ millions cars in year 1922. It is estimated that 1,800,000 are needed for replacement. Truck capacity average 1.2 tons ; 83 per cent 1 ton or under, 2.9 per cent 5 tons or over.

11. *Motor Taxation*: 1922 state taxes 216 million, equal total spent on federal aid roads. Total taxes 335 million exceeds total taxes paid by all the railroads combined.

12. *Road Building*:

"Improved Roads"	350,000 mi.
Primary system completed..	71,500 mi.
Secondary system	98,000 mi.
Federal Aid roads under construction	19,187 mi.
Total road mileage	2,800,000 mi.

13. *City Land Values*: Increasing between 1.7 power and square of population. This purchasing power of cities for public improvements, independent of private capital. Terminal land values probably much faster.

Conclusions on a Transportation Program

1. Steady growth of transportation demand and limited new capital supply renders imperative the maximum use of and efficiency from all carriers, rail and road. Both are equally responsible for the cost of consumed products of soil or factory. Water carriers also share this responsibility.

2. Terminal evolution in the transportion gateways and large centers offers the greatest hope of maximum increased capacity with minimum investment, in which rail, motor, ship, barge and trolley must each play its part.

3. More movement, not more cars, is the great need, quicker turn around for car, ship, barge and motor. The cost of idleness is often greater than that of movement, in a peak load business, such as transportation.

4. Organize, consolidate and plan "off-rail" movement, so as to reduce wastes and delays in haulage, needless multiplication of part-used facilities and resulting fixed charges of idleness.

5. Organized contract delivery in the cities, and motor haulage in the country can not fail to reduce the cost burden of transportation to the consumer, the glutting of railroad terminals and increase the price received by the producer through reduced price spread.

6. Rail systems, both steam and electric, should have the prior right of and be encouraged in adopting motor transport where economically justifiable to avoid needless dissipation of investment and insure lowest combined transport costs. The contract agency plan appears entirely feasible.

7. Scientific research is rapidly determining the economic length of haul of roads vs. rail. We should accept the result and reorganize short haul movement accordingly.

8. Better cost accounting is an imperative need, the only sure road to knowledge of true construction and operating costs, or profits and losses. Visionary profits mean dissipation of capital in the end. This applies equally to railroad terminal operations for which there is now no official accounting standard.

9. Highway transport should be regarded as a complete business, including both roadway and vehicles and should

carry its own burdens—Pay-As-You-Use. But there is no justification in adding the burdens of a future generation to those of the present.

10. The fair principle of proportional distribution of costs with benefits in highway development is by no means yet accepted, but it is bound to come and careful economic research is awaited to establish the basic facts.

11. Inland waterways will find their economic level, if permitted to develop without undue restraint. Their possibilities as trunk-line carriers in rail-water hauls, both lake and river, have not been realized. Nor have the proper distribution of costs and benefits of waterway improvement been though out fully. It is the same problem as of the highways.

12. The serious problem of city and traffic growth has emphasized the necessity of decentralization, spreading our industries, developing our smaller communities. Local feeder roads, while also important in the general scheme, can not fulfill the entire need.

13. Entrance and by-pass city thoroughfares are, perhaps, the most important major traffic controls of the future. Little appears to have been accomplished in this field.

14. Street and roadway capacity is the key to the future. Usually depends on the number of effective traffic-ways rather than gross street width. Arcading narrow city streets may have to come as the only quick relief possible.

15. Developments of strategic railroad entrances for rapid transit and motorways offers great hope for reducing future transport investment and realizing upon the immense values of existing rights of way.

16. Rise in terminal land values must eventually force more intensive development or recession of freight and possibly passenger facilities with motor delivery.

17. Motorizing terminal service may become the best and only interim measure to develop needed capacity, at least capital cost, to realize the immense terminal land values. And this may be the means of leading away from the embarrassing problem of terminal "absorptions," the crux of the railroad rate problem.

18. Use and support of public streets and highways has now become an essential part of the whole transport plan. The public must now determine whether its own best interests lie in competition or co-ordination; taxation or subsidy; whether such use is in public or private interest. Discrimination will likely ensue unless the policy is broadly conceived.

19. The "twilight zone" of cheap property, surrounding the central district of our cities, can find a new use for organized in-town storage of business cars, a necessity if limited parking is to be enforced justly.

20. Metropolitan District Planning, 5, 10, 20 years ahead is today one of the greatest public needs in transportation, to avoid confusion existing among small regional communities and serious delays in public improvement. It may offer the best practicable substitute for "Home Rule." The transportation plan involves streets, railroads, terminals, transit, port and warehousing systems, all co-ordinated with the general city plan, i. e., zoning and other matters of public interest and welfare.

21. The terminal system, rail, transit, street and motor needs first study. For our traffic, in proportion to population, is growing by multiplication; our facilities by addition, if at all. Temporary expedients are only "paregoric;" a fundamental cure must be found and found soon.

22. That integration of the operating elements of a transport system must be brought about in the public interest even prior to actual consolidation is set forth in the New England Rate Division case, recently decided. By the same token terminal unification, in its broadest sense, is an equal duty.

The foregoing paper by Mr. Bibbins was presented before the recent annual meeting of the National Highway Traffic Association.

THE POSSIBILITIES IN INLAND WATERWAY DEVELOPMENT

By C. A. Newton, Representative in Congress from Missouri, in Address Before U. S. Chamber of Commerce

The greatest question before the country today is the solution of the transportation problem. What will be solution be? Will it be the building of more railway lines and more equipment? If so, who is to furnish funds? Do you know of any capital in this country seeking investment in railway securities? If capital will not invest in railway securities, shall we undertake, from the public treasury,

to supply the necessary funds and embark on another era of government operation? By experience we have learned the cost of such an undertaking. Why not adopt a national policy of assisting the railroads by developing and using other methods of transportation, especially if such other methods can produce a cheaper service?

We have expended in this country during the past four years, through federal and state appropriation, a sum in excess of $2,000,000,000 for the improvement of our highways. These highways are making it possible to gather our products from the fields, the factories, the mills and the mines, and to assemble them along the great rail lines of the country, but the rail lines are annually becoming less able to distribute these products as the commerce of the nation demands.

We have in this country great natural trunk line waterways. They penetrate our great industrial and agricultural districts; they flow by the gates of our cities where industry is being retarded by lack of facilities for transportation, and thence they flow out to the sea. Today they are rolling idly through our valleys, contributing nothing toward the nation's wealth. Why not improve them and use them? Why not make them a part of a great transportation system composed of highways, railways and waterways, not engaged in destructive and wasteful competition, but co-ordinated and co-operating with each other?

Is Waterway Development Practicable?

First of all, is the development of our waterways practicable? Can they be made of any real assistance to the railways and highways in carrying the commerce of the country? Can they be made a part of a great system of transportation capable of meeting the demands of commerce?

I know of no better answer to these questions than a study of the results of the Government's experiment upon the Mississippi River. As you are doubtless aware, the War Department is operating a barge line upon the Mississippi between St. Louis and New Orleans. Its equipment consists of 39 barges and 8 towboats.

That operation has been handicapped by the failure of Congress to provide sufficient funds with which to improve the Mississippi River between Cairo and St. Louis. It has been further handicapped by the lack of sufficient equipment to reduce the overhead expenses and to insure an economical operation. This operation has been further handicapped by the lack of adequate facilities and by the lack of co-operation on the part of the railroads.

Unfair Rail Rates

The barge line has been further handicapped by rail rates upon lines paralleling the river. For illustration: The rail rate on 100 lbs. of sugar from New Orleans to St. Louis—718 miles— is $1.55½, while the rail rate upon 100 lbs. of sugar from New Orleans to Fort Smith, Ark.,—494 miles—little more than one-half of the distance but off the river, is $1.94½, and the barge line is permitted to charge only 80 per cent of the rail which parallels the river.

Another handicap with which the barge line has had to contend has been the division of freight between the rail and water lines. For illustration: The joint rail and water rate, per 100 lbs. upon first class freight between St. Louis and Bayless, Ark., is $1.55½. The railroad hauls the freight 74 miles and takes 88½ cts. of the freight. The barge line hauls the same freight 306 miles and gets 67 cts. of the freight. Upon the same class of freight from St. Louis to Monroe, La., the railroad haul is 239 miles, and it takes 48 cts. of the freight collected. The barge line haul is 408 miles, and it receives only 35 cts. for its service.

These instances might be multiplied, but it is interesting to note that in the face of all these handicaps, the barge line has operated successfully and has yielded a profit to the Government. As a fair illustration of this operation, the Mississippi Barge Line during the first six months of last year carried 430,533 tons of freight, for which service the shippers paid $1,641,990.11. The total expenses of the barge line operation during this period amounted to $1,289,224.01, leaving a profit to the Government during the six-month period amounting to $352,776.10, which was enough to pay the depreciation upon the reproduction cost of the entire equipment and to earn on an annual basis 7½ per cent upon the investment.

The barge line earned this profit carrying freight at 3.05 mills per ton mile, while the average rail rate of the country, as shown by the records of the Interstate Commerce Commission, was 10.76 mills per ton mile. True, the distance from New Orleans to St. Louis is one-

third greater by barge than it is by rail, but even considering the barge rate upon the rail distance, the barge line earned a profit in the face of all the handicaps which I have enumerated, and carried freight at less than 50 per cent of the average rail rate of the country. This successful experiment under government operation should be sufficient to remove the last lingering doubt in the most sceptical mind as to the practicability and benefit to the shipper of the improvement and use of our inland waterways.

A striking argument in favor of the improvement of our inland waterways and their use as a part of the transportation system of the country, and their potentiality as a part of that system in supplying facilities for transportation adequate to meet the needs of our commerce, will be appreciated when I tell you that one towboat with its fleet of barges makes the trip from St. Louis to New Orleans in a period of 6 days, carrying enough freight to load 12 full freight trains with 50 cars to each train and 50,000 lbs. to each car. One towboat with a fleet of six barges loaded with steel made the trip within the last month from Pittsburg to Cairo in a period of eight days. Three of those barges were taken to St. Louis with steel, which was transferred to railroad cars at St. Louis, destined for the oil fields of Wyoming. These three barges alone, constituting one-half of the fleet, carried enough to load 300 freight cars; and the shipper upon these three barges alone, in the difference between the cost of transporting this steel by water from Pittsburgh to St. Louis and the rate which the rail lines would have charged for the same service, saved in excess of $7,000.

Shippers in every congressional district in Ohio, Indiana, Michigan, Illinois, Missouri, Iowa, Nebraska, South Dakota, Wisconsin and practically all of the congressional districts in the southern portion of the Mississippi Valley, were patrons of this line.

The Demand for Lower Freight Rates

A question which is rapidly becoming a burning issue in this country is a demand for cheaper rates for carrying our freight. I am not one of those who believe that the railroads can make substantial reductions. I believe that they are doing their best to economize and reduce rates. I do not believe that they are making excessive profits, and I am sure that their income in not sufficient to enable them to pay a reasonable return to the investor who contributed the funds for their construction.

If the railroads are unable to afford cheaper transportation, why should not the shipping public be permitted to enjoy the benefits of cheap water transportation where such transportation can be made available? And then, as a matter of justice and good public policy, the railways should be permitted to charge a compensatory rate—a rate sufficient to maintain their equipment, defray their expenses and pay a reasonable return to the investors in territory where cheap water transportation can not be made available.

In the Mississippi Valley there is an abundance of slow, heavy freight which it is not profitable for the railroads to haul, and which is demanding an opportunity to use the waterways. The government barge line has demonstrated that there are large quantities of sugar, coffee, and other heavy commodities, as well as goods from foreign shores, seeking water transportation to the North from New Orleans, and vast quantities of coal seeking to be carried from the coal fields of Illinois and Kentucky to the St. Paul and Minneapolis district to be used for heating and manufacturing purposes. There are large quantities of iron ore in the Minneapolis district seeking cheap water transportation southward. There are steel and iron products, tiling and brick in great quantities, and other heavy commodities seeking transportation to the south. Kansas city, St. Joseph and Omaha are in the greatest wheat-producing area in the country. Hundreds of millions of tons of this heavy freight each year are seeking to go, either in the form of grain down the Missouri and Mississippi to the sea, or in the form of flour down the Missouri and Mississippi to Cairo and up to the Ohio to the great industrial district around Pittsburgh.

The Way Ahead

If our waterways are improved, all this heavy, sluggish freight can be carried profitably by barge lines at a rate of not more than one-third, and probably one-fourth of the best rate which the rail lines can afford to make. As it is today, we are suffering a shortage in transportation, because hundreds of thousands of freight cars are engaged in the long haul of heavy, unprofitable freight from the interior to the seaboard; and the railroads are suffering not only because of

this unprofitable business, but because thousands of their freight cars, engaged in this service, are lost upon foreign lines. If this low-grade, heavy freight could be loaded upon barge lines and the cars now engaged in that service released for carrying expensive, high-grade freight on shorter hauls, not only would the rail lines be benefited and our transportation difficulties greatly relieved, but our shippers would be immeasurably benefited by the cheap rates which would inevitably result to them.

Give us a great transportation system made up of railways, waterways and highways, not contending but co-operating. Let each factor of this great system supply a service at the lowest rate of which it is capable, and let the shippers pay to each of them a rate which is compensatory for the service rendered and which will yield to the investor a reasonable return upon his capital. Yes, more than that, let us have a great system of transportation, with highways developed so that the motor truck can go to the farmer and into his fields and assemble his commodities along the rail lines. Let us have railways, a larger unit of transportation to assemble these commodities, especially the slow, heavy commodities, along our inland rivers, where the barge line—a still larger and cheaper unit of transportation—can carry them to distributing centers or to the seaboard of the nation.

Before a system of transportation such as I have described can be realized in this country, two things must be accomplished:

First, the projects for the improvement of our inland rivers which have been established by act of Congress, should be completed, in order that these rivers may be made ready and available for navigation.

Second, the rail abuses should be abolished by law, and the rail and water lines should be converted from conflicting, contending forces to a co-ordinated, co-operative system endeavoring to serve the commerce of the country. When such legislation is enacted, which will guarantee freedom from ruinous and confiscatory competition, abundant capital will be available for investment in river equipment sufficient to supply every demand of commerce for river transportation.

THE TRUCK AS THE RAILROAD'S ALLY

By Roy D. Chapin, Chairman of the Board, Hudson Motor Car Co., Detroit, Mich.

The actual competition between rail and motor carriers today is negligible; and where it does exist, it is largely due to the fact that the rail lines, suffering from undue regulation and cramped beyond reason financially, have been unable to provide desired facilities.

Relief for the railroads from the unprofitable short haul, or rate increases which will make this service pay for itself, seem to offer solutions to their difficulties. Perhaps use of gasoline equipment such as that now employed by forty railroads will serve in many cases.

As for the long haul, the plain fact is that the motor vehicle operator does not want and does not believe in it, save under exceptional conditions, and usually these have been forced upon him.

Last year the motor industry, for example, was compelled to drive away from the factories more than three hundred thousand motor vehicles for delivery to buyers. Does anyone believe that this was done from choice? Is it not apparent at once that only lack of rail facilities forced an uneconomic movement of this character? Incidentally, does this not show clearly the necessity for a prosperous, efficient rail system?

In the case of passenger travel, perhaps the steam lines would do well to consider long bus operations, especially in scenic country, as a supplement to their rail facilities.

The field of operation in the terminal area appears to be one solution to the question which has not yet been given full consideration.

Responsible railroad executives have said that 25 per cent of railroad equipment is absorbed in the haulage of less than 5 per cent of the commodity movement and that it returns but about 10 per cent of the revenue.

This is the less-than-carload movement, in which is involved most of the terminal troubles to which the railroad men of the present generation have fallen heir.

Terminal facilities, taken to mean all other than main line facilities, another authority has said, represent about 50 per cent of the total capital investment of the rail lines.

Much present railroad practice is a heritage of the horse-drawn days of high-

way traffic. Then the railroads had to place their stations close together, close to industrial areas, and had to use freight cars over short spurs to facilitate freight movements.

As our cities have grown, the valuations on these terminal properties have swollen to unbelievable proportions, carrying with them enormous increases in fixed and operating expenses. The facilities are no longer adequate, yet to add to them would cost stupendous sums.

Once added, the result would be a congestion of our city streets even worse than that of the present, and at best relief would be but temporary.

Now consider the alternative. The railroads instead of coming into the center of the city for freight terminals could afford to move them well out, selling their down town property. Not only would terminal charges be lessened, but the charge to the average merchant would be lower, since a trucking movement is necessary anyway and since his truck could clear more quickly if it did not have to go through crowded city streets or wait for hours at overloaded platforms.

Automatically, such an operation would release thousands of freight cars now used for deliveries, to spur lines, and the merchant would see his long-distance cargoes coming through more quickly, with a resultant decrease in the interest charges on his investment.

City development would be permitted to proceed in a more orderly fashion, the danger of closed factories due to delayed shipments of necessities would be avoided, and the wheels of commerce would move more smoothly all along the line.

Passenger traffic does not afford as critical a problem, since, as someone has put it, "the goods deliver themselves."

A store-door delivery service furnished by an organization entirely apart from the railroads which would contract to take the goods from the producer's platform and place them at the gate of the consumer, using the rail or water for the long haul and the truck for the short delivery, seems to be one answer to which we are tending.

If we can progress to this point, then the shipper will have completed transportation involving the shortest length of time for each operation. He will find his inventories cut down, as he will no longer have to carry huge stocks on hand; the interest on goods in transit will be decreased; fresh goods can be constantly maintained ;and the greater turnover, of course, means a greater profit.

Similarly, the railroad will have its capital charges, as well as operation costs, reduced, and its equipment left free for use in the profitable long haul.

One of the best forms of transportation which we shall see in our day will be the perfection of the unit container system which is now being tested by the New York Central and perhaps other rail lines. This involves the use of a unit body which can be transferred from truck to train, to boat, to electric line, to truck, without repacking and by a simple crane operation.

The questions of a closer co-ordination of motor bus and electric line in the serving of urban and interurban passenger traffic have afforded investors in traction stocks some anxious moments in the past, but the relations in these fields are now generally understood to be complementary rather than competitive, and with that point in mind traction operators are now going into the bus field.

The electric line, either surface or subway, is the present great purveyor of mass transportation in the cities. Differences of opinion have developed among experts as to the future trend of this traffic. What is the field of the bus line on the main thoroughfares of cities? Have London and Paris something to teach us in this respect?

It is quite natural that the advent of a new form of transportation should bring with it new problems and obstacles which must be overcome before the public and other transport agencies can reap the full benefit of its use.

When the railroads were first developed, history shows that they were not properly appreciated, and it was only as the public came to a realization of their possibilities as carriers that they were accorded full recognition.

The rise of modern highway transport is without parallel in the rapidity with which it has won popular favor, but there still remains much to be done before we can achieve that completed transportation which the public demands.

As one case in point, while we now have some 350,000 miles of improved highway, 259,000 miles of railway, 18,000 miles of interurban electric line and 15,000 miles of inland canals and waterways, none of the older forms of transport can reap the full benefit from highway transport until a much larger percentage of our

2,800,000-odd miles of highway are made ready for constant traffic.

Government surveys in Connecticut, Tennessee, Maryland and elsewhere show conclusively that by far the largest percentage of traffic, even over our main highways, is purely local. Highways, paralleled by other carriers in many instances but still largely destined for "feeder" uses, must be improved in every state, in order that the rail, water and electric lines shall realize their full volume of travel, and, more important, that the public shall derive the benefit of lowered transport charges, which logically and naturally follow improved highways.

At the same time, politics must be eliminated from our highway program an dcentralized economic and engineering control should determine the order, character, and extent of road improvement upon a basis of future traffic requirements. There should be a definite correlation between interstate, state, county and local systems; and the annual highway budget should be adjusted to relative tax needs for other public purposes.

A charge which the public is now subject to is excessive special taxation levied against transportation agencies, which the public as consumers of the commodities must pay.

Thus, for example, a study made from government figures by John E. Walker, formerly tax advisor to the Treasury, shows that the rail lines contributed approximately $304,000,000 in taxes in 1922.

Motor users paid special taxes of $340,000,000 in 1922, or the equivalent of nearly one-half of the total highway construction and maintenance bill of the nation, estimated at $742,000,000. Of that amount, $120,000,000 were discriminatory taxes levied by the Federal Government and exactly comparable to those railroad taxes which, also growing out of the war, were repealed by a recent session of Congress.

We take no issue with that portion of the remainder expended in the upkeep of highways, as we believe that the user should pay a fair charge for service rendered. But those taxes which are levied for construction or which do not go into highway work at all, constitute the payment of general benefits through special levies which add materially to the cost of the public of this form of transportation.

Other large taxes are assessed against the electric lines and other carriers, yet inevitably the consumer must pay. In all these cases, then, we have an artificial barrier imposed in the way of efficient transportation at the lowest cost to the using public.

Inevitably, too, these barriers must be recognized as standing in the way of the most effective use of the motor by the rail and electric lines.

It seems further that the motor truck and the passenger car must take the place of thousands of miles of short-line railroads which were originally built and operated only because the cheaper and more flexible medium was not in existence.

Again, it is apparent that rules and regulations designed to cover old forms of transport can not always be made to apply to a new form.

For example, there is the question of proper regulation of the motor. Of course the vehicle should be required to comply with every regulation having to do with the safety of life, limb and property. That is fundamental. Overloading should not be tolerated nor reckless driving. There should be reasonable restrictions to protect the highway, but there should also be a recognition that the highway is of service only as it is used; and, accordingly, there should be a proper balance between road and vehicle as well as between vehicle and road.

Proper correlation of traffic is likely also to imply exclusive franchises in return for the regular service which the public has a right to demand.

I have already tried to indicate the far-flung influence of highway transport on our ways of life. We can not hope to see that influence fully realized unless we make systematic efforts to increase our facilities in our cities as well as in our rural communities.

The evils of congestion in densely populated areas tend to slow down every form of transport, and in doing so they stem the flow of people and business, to the injury of all transportation and of the public.

There must be extended research, and our universities and other educational institutions must train thousands of men for us, if we are to obtain adequate answers to this highly complex problem of completed transportation.

The responsibility for finding the answer to this question rests with the motor industry, the railroads, the other carriers and the lawmakers.

But over and above all remains the ever-paramount need of conserving the

welfare of the public, and of the nation, if you please. We can only attain the desired goal if we keep that need always in mind.

The foregoing address by Mr. Chapin was delivered before the recent annual convention of the Chamber of Commerce of the United States.

PAINTING CONCRETE SWIMMING POOLS

The question of keeping concrete swimming pools in good condition during the coming season is now uppermost in the minds of many athletic managers and municipal directors. The following statement prepared by an expert and appearing in the "Oval," the house organ of the Du Pont paint and varnish lines, gives some interesting data on this subject. Under the heading "Painting Concrete Swimming Pools," the author says:

The success of a job of this kind depends more on the correct application of the paint than on the paint itself. One of the essentials is plenty of time to permit the different coats to dry properly and the final coat to dry hard.

First, the surface should be thoroughly cleaned. Grease should be removed by washing with gasoline, and dirt by washing with soap and water. The surface must be thoroughly dry before the first coat is applied, in order to permit the proper penetration of the paint.

The first coat should be white enamel undercoat, thinned with elastic wall primer if the surface is of a porous nature, and with turpentine if the surface is hard and non-porous. It is essential to get good adhesion in the first coat.

The second coat of white enamel undercoat should be applied as found in the container.

If the surface is rough, a third and fourth coat of white enamel undercoat is advisable. The coating, when completed, must be continuous so that there are no breaks in the film whatever, which would permit water to get back into the concrete and later force the paint away.

The job to be finished should be given two coats of bath tub and refrigerator enamel.

If the different coats are given sufficient time to dry, the procedure as outlined will produce as satisfactory a coating as anything that can be offered for painting concrete surfaces which come in contact with water.

The three prime essentials are:

1. Dry surface.

2. Plenty of time for the different coats to dry.

3. The finished job must be an impermeable unbroken coat, so as not to permit water to get back into the concrete.

EVINRUDE PUMP SAVES FIRE-THREATENED TOWN

Reports recently appeared in the Duluth daily papers telling how the little town of Central Lakes, Minn., was saved from fire by the use of an Evinrude Centrifugal pump. Forest fires had been threatening this village of 150 inhabitants for some time but by consistent back-firing it had been saved. Upon this occasion a sawmill outfit had just been burned out and the fire was moving toward the main section of the village. The pump was brought through three miles of flaming roadway by two National Guardsmen. It was lowered into a cistern under the parlor floor of one of the Central Lakes homes and the stream of water which it threw on the fire, together with the efforts of a bucket brigade, succeeded in halting the progress of the flames.

VALUABLE TRADE LITERATURE

Crushing and Screening Plants: Austin Portable Gyratory Crushing and Screening Plants is the title of Bulletin No. 30, recently issued by the Austin Manufacturing Co., 400 N. Michigan Ave., Chicago. The bulletin is well illustrated and contains 16, 6x9 in pages. The newest equipment featured in the bulletin are the conveyor and the No. 4 crusher. This company now offers a complete portable crushing plant that fills the requirements of the most discriminating engineers, contractors and public officials. Some of these crushers are mounted on trucks making them easily moved from place to place by the traction engine used to drive the crushing plant. The portable gravel feeding conveyor is a great labor saver on gravel pit operation. It is made in lengths from 30 to 50 ft. and has a belt 18 ins. wide. The conveyor hopper is fed through a trap from wagons, wheelers, drags or fresnos and provides a uniform continuous feed to the crusher thereby greatly increasing its capacity.

Construction News and Equipment

THE SOMERVELL GASOLINE HAMMER DRILL

A Gasoline Impact Drill of the air hammer type is now manufactured by the Pennsylvania Gasoline Drill Company, Land Title Bldg., Philadelphia, Pa.

This drilling unit is an innovation in the drilling equipments now in practical use, it being a self-contained, portable, gasoline hammer, so powerful and compact that one man operates and transports it from place to place. Like the self-contained gasoline engine, this gasoline hammer makes its own power, therefore no other power equipment has to be transported with it.

When first seen in operation, the lack of connection to other agency of power causes wonder and forcefully brings a realization of the great power of gasoline when applied directly to the hammer piston of this drill.

The drill was first developed for drilling rock, but, because of its portability and simplicity, the advantages of its application to other work are recognized in many other lines of business such as:

Cutting asphalt streets, breaking concrete, picking hard earth, ramming back fill in trenches, removing granite block, removing wood block, drilling foundations, drilling through walls, driving tie spikes, ramming tie ballast, paving repairs, stripping, shaft sinking, and exploring.

Prior to this invention, all types of power drills were limited in their application to work by the length of an air hose or by electric wires. Power for either of these methods must be supplied to them by an auxiliary power equipment which, on account of the size and weight, cannot be cheaply transported, nor can it be located near enough to do probably more than 60 per cent of the work to which a power drill could profitably be applied.

The table gives comparative data of the weight, purchase price and practical operating costs of the gasoline drill and mounted air drilling equipment, an equal amount of work being assumed.

	Portable Air Drills	Somervell Gas Drills	Saving
Average weight	3,000 lbs.	70 lbs.	2,930 lbs.
Average selling price	$1,800	$600	$1,200
Daily gasoline consumption @ 27c gal.	16	1½	$3.91 a day
Labor @ $4.50 a day	2 men	1 man	$4.50 a day

Transportation and upkeep costs, not estimated.

Opening Philadelphia Streets

The Philadelphia Electric Company, by the direction of Mr. J. Wilson Sylvester, Superintendent of A. C. and Arc Underground Lines of that Company, has made

COMPLETE DRILLING UNIT OPERTING

tests of the gasoline hammer extending over several weeks' time. The work included the operations required for the opening of city streets.

Particular attention was paid to the performance of the gasoline hammer in such work as cutting asphalt, breaking concrete bases, picking frozen earth and tamping back fill. Records of the saving in labor costs of the various operations were carefully kept.

The following is the average time in which the gasoline hammer will do the

work as compared with the time required by hand labor, paid $4.50 a day:

	Hand Labor	Gasoline Hammer	Daily Saving in Labor
Cutting asphalt surface	2½ men	1 man	$ 6.75
Breaking concrete base	5 men	1 man	18.00
Picking frozen earth	2½ men	1 man	6.75
Ramming back fill	8 men	3 men	22.50

For ramming back fill a cast steel tamper 8½x8½ ins. is used. The back fill is so solidly compacted by the gasoline hammer that after the installation of a service conduit 4½ ins. square for the length of the ditch, it was found possible to replace all of the earth removed, thus insuring a more substantial foundation than existed before being disturbed. This precludes the possibility of future settlement as well as eliminating the cost of removal of surplus dirt.

It appears to be practically impossible to re-compact the earth by hand labor to prevent it from later settling and causing a depression, but the gasoline hammer will re-compact the earth as tight and as hard as when first removed.

Telegraph Pole Lines

Because of the lack of sufficiently portable power drills, the Western Union Telegraph Co. has experienced difficulty and great expense when excavating for pole lines in rocky and inaccessible places. Upon their engineers witnessing the performance of this gasoline hammer drill and seeing that it can easily be taken wherever man can go, its advantages for this and many other kinds of work were recognized and an order for a number of them was given.

Gasoline Drill Construction

The mechanical principle of this gasoline hammer drill combines the action of an air hammer and a gasoline engine in such manner that the drilling unit has but two moving parts, the hammer piston and the fly wheel assembly. No crank shaft or connecting rod is employed and there is no spring or other yielding member used in the internal construction. No inlet or exhaust valves or cam shafts are used, as the air and gas passages are fixed ports, cut through the solid steel of the cylinder.

The down or power strokes of the hammer pistons are made with approximately 900 lbs. of gasoline explosive force thrusting it forward to hit the drill bit with terrific force. The fly wheel is employed only to return the hammer piston on the upward or compression strokes. Approximately 1,800 impacts are struck each minute. For carburation, a gasoline mixing valve is used which permits the drill to be worked at any angle. While the drill continues to run at full speed, the operator shifts it from one position to another and to any desired angle without affecting its operation. To start the drill, the operator has but to give the rim of the fly wheel a pull by hand and even in the coldest weather it starts "with consistent regularity" as was remarked by Mr. W. K.

DRILL WITH STREET OPENING TOOL

A prominent engineer writes: "Your 'Maintenance Manual' is the most constructive piece of road literature that has come to my attention in years. Congratulations."

A Road Maintenance Manual Every Engineer Should Have

ROAD authorities know that eternal maintenance is the price of good roads; that haphazard patching and treating of highways is more costly in the long run than a system of regular upkeep.

This manual shows how every type of road and pavement, except earth roads, can be easily repaired and maintained with Tarvia.

Whether or not you use Tarvia, this booklet will prove of great benefit to you in your work. "Road maintenance with Tarvia" is recognized by engineers and road authorities as the most complete and helpful booklet on road maintenance that has ever been published.

A copy will be gladly sent free on request to our nearest branch office. As the number of copies is limited, we suggest that you write for your copy today.

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Lubrication of all parts of the drill is assured by the means of scoops, fixed to the hub of the fly wheel, which in turn, runs in a reservoir of oil and delivers a copious supply to all moving parts. A pint of oil will lubricate the drill for a week. A four or six dry cell battery is used for ignition.

Under the guidance of metallurgists

RAMMING BACK FILL

having long experience with steels of high fatigue values, special alloys having 210,000 lbs of tensile strength are used in the impact members of the structure. To avoid checks, flaws and other imperfections such parts are machined from solid steel billets. When heat treating these parts, recording instruments are employed to avoid unknown variations in the heats thus assuring uniformity in the steels.

The manufacturing of the drill is done under close inspection. Machining dimensions with very close tolerances are fixed to assure the interchange of repair parts. Highly skilled mechanics are employed working under experienced management.

Three years of uninterrupted application to the development have been spent in bringing this gasoline hammer drill to this stage of perfection, and it has been refined to such an extent that a monkey wrench and a screw driver only are needed to take the whole drill apart and to put it together again, no mechanical skill of any degree being necessary.

CARRYING SERVICE TO THE "CATERPILLAR" OWNER AND OPERATOR

The Holt Manufacturing Co., recognizing the need for greater tractor knowledge on the part of owners and operators of "Caterpillar" tractors, is meeting the problem in the most direct and thorough manner. A complete educational program is in operation, one of the important features being service schools, conducted at various points throughout the country.

In these schools special attention has been given to the mechanical equipment of each model "caterpillar." Complete tractors, cut away assemblies, including engines, clutches, transmissions, roller frame assemblies, etc., are used. These assemblies are so prepared that not only can the student closely follow and materially profit by the instructors' explanatory lectures, but in the shop work which follows every lecture, the student, by virtue of the special cut away features, can more readily carry on with the work assigned him of disassembling and reassembling.

The school work is sufficiently long to cover every feature of the construction, operation and maintenance of "caterpillar" tractors.

These schools are carried on under the personal supervision of H. H. (Jack) Chambers, Service Manager of the Holt Manufacturing Co., aided by H. S. Hinrichs, Assistant, and Messrs. Earl J. Howey and Jack Westphal, Service Instructors, all men of broad experience in all phases of tractor work. These schools are meeting with the hearty approval of customers.

In addition to service schools, the educational program includes instruction books furnished every user and a continuous follow-up of service bulletins and letters of advice relating to "caterpillar" tractors. The results the Holt Manufacturing Co. is obtaining conclusively prove that he who serves to the utmost profits most in the end.

EDITORIALS

THE UMPIRE

Rare pleasure was experienced in coming upon the following paragraph in an article published in this issue:

"When commerce brings together an aggregation of people to form a town, they, in order to live together harmoniously, elect a set of officers to umpire the game. There is no state constitution that gives to any city council any power other than that of an umpire."

Some may say that "referee" would be better than "umpire," contending that community life is rather more like a boxing or wrestling bout than a baseball game. The point is not one to detain us; "umpire" suits well enough.

The figure will please many and, perhaps, displease a few. We find much in it, to admire and shall remember it, pleasantly, for many days to come.

The attitude of the public toward public officials is very much like its attitude toward baseball umpires. Each class is condemned on general principles as well as for specific acts of omission or commission. "The umpire is a most unhappy man," in the words of an old song. He is accused of almost everything except being honest and competent, whether he is umpiring community life or a ball game. The treatment accorded baseball umpires mars that otherwise great sport and the treatment accorded public officials is nothing short of a disgrace. Some people respect and admire the public official, it is true, and some followers of the great national game admire the umpire. Such admiration, however, is seldom expressed and is confined to a very small class, perhaps to those in the "box seats." Those in the "bleachers," in either game, life or baseball, are sure the umpire is dishonest and incompetent. When all the fans admire the umpire we may expect the public to accord decent treatment to public officials.

Umpiring is unpleasant in many ways; it may be dangerous. The umpire's rewards are not great, yet life as an umpire must have its compensations. Perhaps the veteran umpire, Tim Hurst, explained it when he said: "You can't beat them hours." The public official hasn't even the solace of short hours.

DRAFTING AND THE YOUNG ENGINEER

Progress in one great constructional activity waits on the young engineer. In at least one state highway department the production of modern highway bridges cannot be maintained at the desired rate because of the lack of men to get out the drawings; probably the same condition exists in some other state highway bridge departments. In the particular case in mind money is available for building bridges which cannot be built because young engineers, in many cases, insist on outside work and refuse to hump over the drafting board.

We are both glad and sorry that this is true; glad that the young engineer has declared his independence of the drafting room as a place to make a living, and sorry that he is unwilling to spend part of his time in drafting, not only because some designing experience is essential to his symmetrical development, but because his balking at the drafting room door is, to some extent, holding up the great highway development program. The young engineer now has an unusually favorable opportunity to alternate between design and construction in a way which should serve his comfort and convenience and speed his professional development and advancement. Time was when the young engineer bent over the board, until he was no longer young, expecting that his reward would come. The many disappointments experienced gradually found expression and the young engineers of today are much more sophisticated than were those of twenty or thirty years ago. Now they know it takes something more than long service and the willingness to wear darned trousers to achieve advancement. They have learned that the drafting room of the old days was only too often the graveyard of hope. While this is well and while it is very fortunate that young men have learned that they must

be alert for opportunities to advance it is really unfortunate that so many refuse to do any drafting at all, unfortunate for them and for the public. They have gone from one extreme to the other. Probably they will settle down soon to a middle-of-the-road course, dividing their early years between design and construction.

INCREASING FRANKNESS IN CRITICISM OF ENGINEERS

One of the most encouraging signs observed in many years' study of engineers and engineering is the increasing frankness of engineers in their self-criticism. Self study is supplanting self pity to the inevitable advantage of engineers. The pharisaical thanking God that we are not as other men are is giving way to the recognition of the fact that we are members of the human family after all and that if we expect to get along we must adopt the methods of successful men in other lines of work. The "holier than thou" philosophy was discredited long ago and it is rather naive for the engineer to cling to it still.

One of the frankest criticisms of the engineer that has yet appeared is published in the August number of "Professional Engineer," the official journal of the American Association of Engineers. It is from an address by Mr. E. T. Tannatt before the Tacoma Chapter.

He feels that the engineer is severely handicapped by the weight of the "thou shalt nots" he is obliged to carry. He illustrates by saying that if a child is reared from birth in the spirit of "thou shalt not" and in the belief that he is too blue-blooded to associate with other children, that on reaching manhood he will strongly manifest the very characteristics for which engineers have been criticized as a profession. Mr. Tannatt says: "If you will take any code of ethics as laid down for the engineer, and I do not except that distributed by our own Association, you will find that practically every item conveys to your mind (possibly only in a very subtle way) one of two impressions—either that your profession is so 'blue-blooded' as to be above association with the common humanity or business callings, or that 'thou shalt not.' If I am not very much mistaken, you will find that these 'thou shalt nots' almost invariably place over the engineer a dictum that prevents him from taking part in some line of service or opportunity in which he is especially qualified to succeed; also that the same code is not made to apply to business, even when the business world is dealing with identically the same engineering problems."

He cites many reasons for his beliefs, based on things as they are, and concludes as follows: "Just so long as the profession is willing to live by creeds and dogmas and considers itself too good to enter business life in a business way, just so long will the profession be what it is today, namely, no profession at all, and one of the poorest-paid vocations."

THE PERSECUTION OF THE ARMY CONSTRUCTION PROGRAM MEN

In this issue we publish an article giving the truth about cantonment construction costs which is worth reading and preserving. The author is very indignant, and properly so, about the persecution started by Attorney-General Daugherty against the engineers and contractors of the army construction program. The entire construction industry is indignant because of this persecution of some of its most respected members. What can we do about it?

The answer is easy. Simply serve notice on the new President, through our engineer friend, Secretary Hoover, or in any other convenient way, that the construction industry realizes that these suits were filed as a party measure, and that unless they are withdrawn and the accused men exonerated, the construction industry will voice its protest at the polls. This is an argument any administration can understand, especially one that has only a few months in which to make a record on which it can go to the people for approval.

We believe the truth with respect to these charges is very adequately expressed in an editorial in a recent issue of Engineering News-Record, in these words: "The whole history of the Construction Division suits and indictments, from the strictly partisan Congressional investigation to the personnel of the staff which is using that investigation as its bible, brands that persecution with political motives. It was plainly an effort to magnify the new administration by discrediting the Wilson administration. Reputable engineers and contractors were to be made martyrs in the process." That is the plain truth, plainly stated.

ILLINOIS TO MAKE EXTENSIVE INVESTIGATION IN SUBGRADES

By H. F. Clemmer, Engineer of Materials, Illinois Division of Highways, State House, Springfield, Ill.

Realizing that the strength of pavement sections is influenced to a great extent by the soil making up the subgrade under these pavements, the Illinois Division of Highways is planning an extensive investigation in soils to study as far as possible the many factors which cause one type of soil to provide better support than others.

Soil Survey Reveals 14 Distinct Types in Illinois

Three years of investigation on the Bates Experimental Road has provided an immense volume of data on the actions and characteristics of the soil making up the subgrade of that road. Bearing power tests, moisture content determinations, soil movements and other tests of this nature revealed the fact that the Bates Road subgrade, consisting of soil commonly known as brown silt loam, furnishes very little support to the pavement slabs at certain times of the year. Though the tests on this type of soil were most complete, the fact that the soil over the State of Illinois is not of a uniform nature makes it impossible to apply the knowledge gained on the Bates Road to all soils making up the subgrade of the State highway system. For this reason it was decided to make a survey of the soils in the State and then subject the different types of soil to various tests. The survey revealed the presence of 14 distinct types of soils.

Planning the Tests

In order to centralize the investigation and in this way make it possible to build more permanent apparatus, it was decided to transplant the different soil samples to the Research Laboratory at Springfield. Samples of these 14 typical types of soil were therefore shipped to Springfield and placed in holes in the ground, 18 ins. deep and 2 ft. square. A concrete curb 6 ins. deep was placed around the specimens and level with the surface of the ground. A 2-in. concrete cover was fitted into this curb and the crack at the junction sealed with asphalt. The purpose of the cover was to prevent the entrance of rain water to the surface of the soil specimens. Through sampling stations in the covers small soil samples are secured at regular intervals for moisture determinations. Figure 1 shows a general view of the layout of the specimens.

Moisture Determinations

The soil specimens were placed in the ground in January of this year and were left undisturbed except for weekly moisture determinations until May 29. Ditches dug down each side of the row of specimens were filled with water on May 29

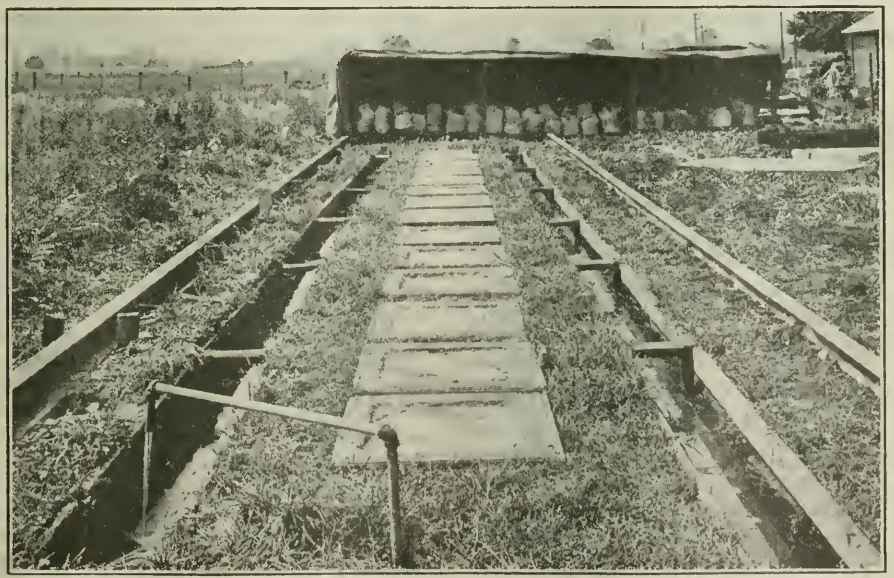


FIG. 1—GENERAL VIEW OF LAYOUT OF SOIL SPECIMENS IN ILLINOIS SUBGRADE EXPERIMENTS

in order to secure a condition similar to the side ditches of a pavement. The studies in soil at the Bates Road showed an extremely small amount of lateral movement of water in brown silt loam soil. The effect of this condition on the soils of other types is to be watched with interest. The moisture contents of the various types run from 45 per cent to 14 per cent of the dry weight of the soil. As all conditions surrounding the placement and treatment of these samples were alike, this great variation in moisture content cannot be due to anything else but the nature of the soils themselves.

Laboratory Tests Being Made

Laboratory tests are now being made to determine the effect of free water, capillary water, surface wetting and colloidal elements on these soils. Before the tests are entirely completed it is hoped that a complete analysis of the various types of soil will have been made. Figure 2 contains a view of the samples prepared for laboratory tests.

Bearing Power Tests

An apparatus is at present being built in the laboratory for use in the bearing power tests. This machine is expected to be capable of applying loads of from 1 lb. to 50 lbs. per sq. in. over a relatively large area. It will be mounted on tracks so that it can be moved up and down the row of soil samples and apply loads where desired.

Types of Soils Tested

The types of soils included in the tests are as follows:

Sample *No. 1.* Sangamon County. Yellow Gray Silt Loam—Backland timber soil. Sample taken Oct. 23, 1922, at intersection of roads, 1¼ mi. E. of Sherman. No sharp line of demarkation between topsoil and substructure. Sample of mealy and silty character. Subsoil more granular and becoming more clayey as depth increases.

Sample *No. 2.* Sangamon County. Deep Brown Silt Loam—Bottom land soil. Sample taken Oct. 24, 1922, at road intersection ¼ mi. N. of Chickapin Bridge on Chickapin road, approximately 5 miles N. of Springfield. No sharp line of demarkation between topsoil and subsoil. Sample almost black and granular; subsoil becoming lighter and still more granular with depth.

Sample *No. 3.* Sangamon County. Black Clay Loam—"Gumbo"—Sticky black prairie soil. Sample taken Oct. 26, 1922, 3⅛ mi. S. and 4 mi. W. of Pleasant Plains. Sample taken to depth of 12 ins. Topsoil very black, sticky and granular when dry —very difficult to work. Subsoil becomes lighter with depth passing into drab or yellowish clay.

Sample *No. 4.* Sangamon County. Brown Silt Loam—Upland prairie soil. Sample taken Oct. 26, 1922, at road intersection 2¼ mi. W. and 1¾ mi. N. of Bradforton. This is the most important and extensive type of soil in the central part of the State and occupies most of the well-drained prairie areas.

Sample *No. 5.* Sangamon County. Drab and Yellow Clay. Sample taken Oct. 26, 1922, at same location as Sample No. 4, but at a depth of 24 to 36 ins.

Sample *No. 6.* Pike County. Yellow Silt Loam—Upland timber soil. Sample taken Oct. 31, 1922, at a point along the road 1¼ mi. N. and ¾ mi. E. of the village of New Salem in Pike County. Sample taken to a depth of 12 ins. This soil occurs on very hilly and badly eroded areas. It is a silty mealy soil which works easily. Subsoil is yellow clay.

Sample *No. 7.* Pike County. Fine Sandy Loam—Upland timber soil. Sample taken Oct. 31, 1922, at a point along the roadside 2½ mi. E. of the city limits of Griggsville, Pike County, and 1 mi. W. of the village of Valley City. Sample taken to a depth of 12 ins. This soil occurs on the very rolling and broken areas. It is of a sandy character and very easily worked. Subsoil is yellow clay.

Sample *No. 8.* Pike County. Brown Sandy Loam—Old bottom land. Sample taken Nov. 3, 1922, at a point along the roadside 1½ mi. E. and 1¼ mi. N. of the village of Chambersbury in Pike County. Sample taken to a depth of 12 ins. This type occurs adjacent to the Illinois and Mississippi Rivers, on areas not subjected to overflow. It is of sandy, easy working character. Subsoil very sandy.

Sample *No. 9.* Pike County. Drab Clay —Swamp land soil. Sample taken Nov. 3, 1922, at a point along the roadside ½ mi. W. of bridge over the Illinois River at Meredosha near subway underneath the Wabash Railway. Sample taken to a depth of 12 ins. This type occurs on the uncultivated, swampy, back-water areas adjacent to the Illinois and Mississippi Rivers. It is drab to black in color and very sticky and difficult to work. Surface cracks 2-in. wide and 1 ft. to 2 ft. deep were present at the point where the sample was taken. The subsoil is similar to the topsoil, underlaid at lower depths with sand.

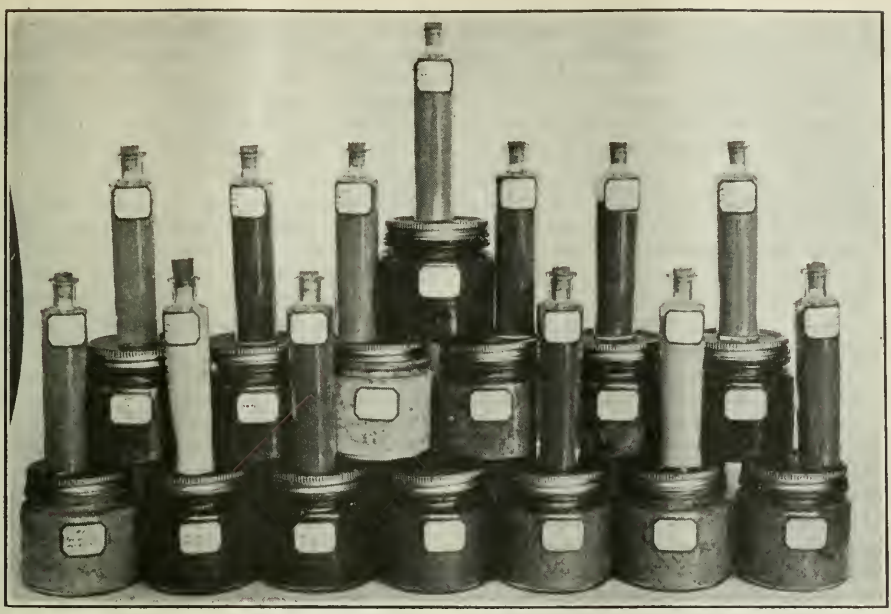


FIG. 2—VIEW OF SOIL SAMPLES PREPARED FOR LABORATORY TESTS, ILLINOIS SUBGRADE EXPERIMENTS

Sample *No. 10.* Bond County. White Silt Loam—Upland timber soil. Also known as "post oak" soil because of the scrub oak which grows on this soil. Sample taken Nov. 9, 1922, at a point on the roadside 2½ mi. N. and 1¼ mi. W. of Old Ripley Post Office in Bond County. Sample taken to depth of 6 ins. The soil is highly silty and looks like wood ashes. Subsoil same as Sample No. 12.

Sample *No. 11.* Bond County. Gray Silt Loam on Hard Pan—Upland prairie soil. Sample taken Nov. 9, 1922, at a point on roadside 2¼ mi. S. and 1 mile E. of the S. W. corner of the city limits of Greenville in Bond County. This is a friable, highly silty loam containing enough clay to make it slightly plastic when wet. Subsoil same as Sample No. 12.

Sample *No. 12.* Bond County. Subsoil. Sample taken Nov. 9, 1922, at location as Sample No. 11. Sample taken to depth of 18 ins. This is a very sticky gummy clay when wet and very hard when dry.

Sample *No. 13.* Sangamon County. Black Clay Loam. Sample taken about Jan. 15, 1923, at Bates Experimental Road. This sample is typical of central Illinois prairie soil.

Sample *No. 14.* Winnebago County. Brown Sandy Loam—Upland prairie soil. Sample taken Jan. 19, 1923, at point on roadside 2 mi. W. of Rockford in Winnebago County. Sample taken to depth of 18 ins.

NEW GARBAGE INCINERATING PLANT ON CHOUTEAU AVE., ST. LOUIS, MISSOURI

(Editor's Note: The following description of the new garbage incinerating plant at the foot of Chouteau Ave., St. Louis, Mo., is from a report on the garbage situation in St. Louis from 1839 to date. The report was written by C. S. Butts, engineer of the Department of Public Utilities, 311 City Hall, St. Louis.)

The Board of Public Service was authorized by Ordinance No. 31494, Feb. 6, 1922, to advertise for bids for two incinerator plants, one at Kingshighway and McRee and one at the foot of Chouteau Ave., and appropriating $140,000 for this purpose. The contract for the Chouteau Ave. plant was awarded May 19, 1922, to the Chicago Incinerator Co. at $69,812. Work commenced June 14, 1922, and was completed Nov. 1, 1922.

There were 68,354 tons of garbage collected during 1922-1923 at a cost of $3.55 per ton. The cost of disposal was $1.60 per ton, or a total cost of $5.15 per ton of garbage. A total of 11,857 dead animals of all kinds was disposed of.

All garbage with the exception of 80 tons per day hauled to the incinerator plant, is being hauled to the present contractors, Klein & Katz, and weighed and dumped onto barges at the foot of Chou-

teau Ave. There are some 130 wagons in service during the summer months, hauling garbage to this point, which, based on 1922-1923 reports, costs $3.55 per ton for hauling and $2.10 for disposal, makes $5.65 per ton. The present wagons weigh about 2,500 lbs. and haul about 1¼ tons of garbage, making the total weight of load 5,000 lbs., or 2½ tons.

The hauling of garbage by motor trucks seems to be the solution of the collection problem. Experiments are now being made by trucks and trailers. This system has reduced the cost of collection, but has not eliminated the mule-driven wagon. A system should be devised whereby collection can be made by tractor and trailer and eliminate the wagons and mules.

There should be 5 incinerators built, 3 of 100 tons capacity on the river and 2 of 150 tons capacity in the central west end, thus reducing the long haul which will greatly reduce the cost of collection during the summer, when about 400 tons per day are collected. The plants would have to be operated 24 hours each day, but during the winter months, when 150 tons are collected, would only have to be operated 8 hours each day.

When the incinerator plants are all complete and in operation, an ordinance should be enacted requiring all garbage to be drained and wrapped in paper before being deposited in the garbage can. This would increase the efficiency of the incinerator plants and eliminate sloppy garbage being hauled through the streets. There should also be an ordinance enacted requiring all hotels to put in their own incinerator plants in their buildings; also all large apartments should be required to put in incinerator plants in their buildings and garbage collected daily by janitor and burned in their own incinerator plant.

It may be seen by following the ordinances and contracts from 1839 until 1923 that most all methods were tried out in St. Louis to dispose of garbage. From 1839 until 1910 it was dumped into the Mississippi River, but from that date until the present it had a hard time finding a place to light, as the government stopped the authorities from dumping garbage into the river.

The reduction method was tried out here first at the foot of Osage St., then Wright and Hall Sts., then in St. Louis County near St. Louis and finally in Illinois, near Dupo, this being the last reduction plant. The public, in general, always objected to the odor and finally drove this method out of business. Then came the hauling of garbage to Chelsey Island by barge, where it was dumped upon the island and fed to hogs (what they did not eat was plowed under the ground). Later it was disposed of by contract to contractors who hauled it to Stallings, Ill., and later to Summit, Mo., and it is now being disposed of to contractors who haul it down the river; it is sold to farmers for feeding hogs. In other words, we are almost back where we started in 1839, as no successful disposal has been found up to this time. We believe we have at last taken a step in the right direction and have built an 80-ton capacity incinerator plant at the foot of Chouteau Ave. (This site was selected probably because the mules were so familiar with this location that they would not feel at home any place else.) We base our conclusion regarding incineration on data that have been gathered regarding incinerators and upon what is being done here and in foreign countries.

It was only after the reduction method had been tried and failed in England that incineration was adopted there, and today there is not one municipal reduction plant in England, so far as I have been able to ascertain, while there are 143 municipal incinerating plants in successful operation. In addition to the above number of incinerating plants in England alone, the three principal cities of Scotland, and the eight large cities of Ireland dispose of their entire refuse by incineration. There is not a large city in Europe, South America, Africa, India, or Australia which does not do likewise. Owing to the prevalence of cholera in the far eastern countries, the question of the collection and disposal of garbage was given for years their most careful consideration, and the incinerating method finally adopted. Both Calcutta and Bombay, India, employ incineration for the disposal of their garbage with perfect satisfaction.

Official reports show conclusively that the reduction process has been a failure in every city in this country which has tried it, and especially so in Denver, St. Paul, Buffalo, Chicago, Milwaukee, Detroit, New Bedford, Reading, Pittsburgh, Syracuse, Paterson and New Orleans.

The refuse of the average American city is of the following composition:

	By Wt.	By Vol.
Garbage	13 per cent	18 per cent
Ashes	80 per cent	57 per cent
Rubbish	7 per cent	25 per cent
	100 per cent	100 per cent

Ordinary kitchen garbage consists approximately of:

	By Wt.
Animal and vegetable	20 per cent
Rubbish, cans, rags, etc.	7 per cent
Grease	3 per cent
Water	70 per cent
	100 per cent

A description of the new 80-ton incinerator plant at the foot of Chouteau Ave. follows:

Foundation:—The foundation consists of forty-nine 20-ft. reinforced, pre-cast concrete piles, driven to an elevation of 95.5 being 6 ins. in the concrete footings, which are constructed to an elevation of 103.2, 1 ft. above the operating room floor level.

Building:—The outside dimensions of the building are 38x56 ft. 1 in., built of brick with steel truss roof. The operating floor is on an elevation of 102.2, being 36 on river gauge.

Operating Floor:—A small office 8x12 ft. and a wash and toilet room, 6x12 ft. with shower are on this floor. Three furnaces (including combustion chamber) 14 ft. 9 ins. wide by 32 ft. long by 11 ft. 6 ins. high are built on this floor. Two forced draft fans, one 10 h.p. and one 20 h.p., are placed on the floor at the north end of the furnaces for furnishing the furnaces with forced draft.

Tipping Floor:—The tipping floor is built on an elevation of 123.2. There are 3 holes 3x3 ft. and 3 holes 1 ft. 6 ins. by 4 ft., which the garbage is dumped into and goes directly into a storage bin (the entire length of furnaces) which is triangular shaped 9 ft. 6 ins. deep with capacity for 60 tons of garbage. Another hole 5 ft. 6½ ins. by 4 ft. 2 ins. is left directly over the combustion chamber for cinerating dead animals. There are also two coal holes 1 ft. 6 ins. by 2 ft. each, for dumping coal into chutes which empty on the operating floor in front of the furnaces.

Clinker Pits:—There are two tracks 24-in. gauge with dump cars to receive the clinkers from the furnaces and dust from the combustion chambers. The space occupied by pits is 11 ft. 6 ins. wide by 32 ft. long and 7 ft. high. These tracks lead out of the south end of the building, thence to the river bank.

Trestle Approach:—The trestle approach leads out of double doors on the tipping floor to the south. The entrance to the plant is by Convent St. A scale is located on the approach direct to tipping floor. A 5 ft. by 125 ft. radial brick chimney is built upon twenty-five 25-ft. pre-cast concrete piles and a reinforced concrete slab 17 ft. by 17 ft. by 4 ft.; chimney is lined with fire brick, 9 ins. for 50 ft. and 4½ ins. for 55 ft., making a total of 105 ft. of lining.

Operation of Plant:—The garbage is hauled up the incline, passing over scales, where it is weighed, thence into the south end of building onto the tipping floor, where it is dumped in holes in the floor into a large storage bin holding about 60 tons. There are 6 openings left in the east side of the bin with steel doors operated by pulleys and weights. Immediately opposite each door is a hole 2 ft. 1 in. in diameter closed by a cone-shaped weight which is also operated by pulleys. Outside of this hole are other steel doors making a closed air lock. The garbage is raked from the storage bin into the 2-ft. 1-in. opening at the top of the furnace, thence diverted onto a drying arch, from which it is raked onto side grates, where it is further dried, thence raked into the fire box of the furnace. The side grates are 5 ft. long by 3 ft. 6 in. wide. The fire box proper is 2 ft. 3 ins. wide, 1 ft. 3 ins. deep and 5 ft. long, making a total of about 60 sq. ft. of grate surface. After garbage is burned the ashes and clinkers are drawn into an ash bin and when cooled off are loaded into small cars in the basement of the plant and dumped in the river. The furnaces are operated with forced draft being supplied by two fans, one 10 h.p. and one 20 h.p.; the air to supply these fans is taken out of each of the 3 ash bins, over the hot clinkers into a 20-in. vitrified pipe, then into an air chamber 3x6 ft., thence through the fans into two galvanized air-tight ducts, one 1 ft. 6 ins. by 2 ft., and one 1 ft. 6 ins. by 3 ft. under the furnaces. Air is also taken out of the garbage bin through a 20-in. galvanized pipe through the fans and into the ducts. Under each furnace and directly under the grates are three 12-in. diameter holes in the ducts. Two of these holes supply air to the side grates and one to the fire box, the supply of air being regulated by dampers over each hole. The fans are so connected and the dampers so located in the air pipes proper that they can draw from ash pits, combustion chamber and garbage bin or separately and can be operated singly or together. The gases from the furnaces pass through a large combustion chamber where a temperature of about 1,200 deg. is maintained. Dead animals can be cinerated in this chamber. The chamber is connected to the chimney

which is 5 ft. in diameter by 125 ft high. All gases and bad odors disappear before reaching the top of the chimney.

In connection with the plant, a 280-gal. tank is provided for hot water and is supplied by two 2-in. pipes placed in the combustion chamber. This hot water furnishes two radiators in the office and the toilet rooms and also furnishes hot water on the tipping floor and firing floor for cleaning purposes.

The building was constructed by local contractors and the furnaces were constructed by the Burke Furnace Company of Chicago, to whom credit is due for the increased capacity of the plant. The plant is being operated by the Department of Streets and Sewers, Clinton H. Fiske, director.

Guarantee:—The guarantee made was as follows: To incinerate 80 tons of garbage in 24 hours without any nuisance or mal odors. To use not over 8 K.W. electricity for forced draft fans per ton of garbage. Tests show that this capacity has been raised to at least 100 tons in 24 hours and that it requires less than 1 K.W. electricity for each ton of garbage and less than 100 lbs. of coal per ton of garbage. It has therefore more than fulfilled the guarantee.

The plant is being operated 24 hours per day in three 8-hr. shifts and requires 3 men on the firing floor, 3 on charging floor and 1 foreman for each 8-hr. shift, and is incinerating garbage without any offensive odors or smoke for $1.00 per ton, or showing a saving of $1.10 per ton over the present contract of dumping it on barges at $2.10 per ton.

It is the intention of the city to erect the other plants as soon as possible, thus eliminating the long haul to this one plant and further reducing the cost of collection.

This plant has been in operation for 5 months and as yet no complaint has been made against this method of disposal of garbage. After 84 years of garbage disposal troubles it is believed that the city has found the proper solution of the disposal of garbage in a sanitary manner.

"OPEN" VS. "CLOSED" SPECIFICATIONS FOR ASPHALT RESURFACING

By C. R. Andrew, City Engineer, Decatur, Ill.

(Editor's Note: The following paper by Mr. Andrew and the discussion of it by Mr. Hittell are reproduced here from the published proceedings of the Illinois Society of Engineers, Inc., for the year 1923).

First, I wish to define the words "open" and "closed" as applied to specifications in this portion of the discussion. By open specifications I mean specifications that are open in a practical and not a legal sense; specifications which will admit the products of a considerable number of competing firms, but not specifications which will necessarily admit all the products of all the firms supplying asphalt. By closed specifications, I mean those specifications which are so written that they will admit the actual (not the possible) use of products of one firm or its subsidiaries. These specifications may be open in a legal sense, as it is possible that in other countries, or in other parts of this country, there may be independent firms manufacturing or producing a product which would fulfill the specifications, but in the particular case in question it would not be practical or perhaps possible for them to do so. With these two definitions in mind I will briefly give you the experience of the city of Decatur in obtaining bids under both "open" and "closed" specifications for sheet asphalt surface on both new work and resurfacing over old two course brick pavements.

In 1921 the city of Decatur inaugurated a considerable program of asphalt resurfacing. This program consisted of about 100,000 sq. yds. of asphalt pavement, the majority of which was resurfacing over old brick, 80,000 yds. of which was under contract during the season. This program was indorsed by the local Association of Commerce and various local clubs. The recommendations of the Association of Commerce were that the asphalt was to be equal to "Trinidad." Specifications were drawn which would practically permit the use of no other asphalt than natural lake asphalt. The fact that no other asphalt was practical under the specifications is evidenced by the fact that when the bids were received none but Trinidad asphalt was bid upon.

The work consisted of closed binder, at least 1½ in. thick with a 1½ in. wearing surface over old brick surface. One project of about 15,000 yds, was advertised. Five bids were received and the prices for that portion requiring asphalt were as follows: For 1½ in. binder and 1½ in. wearing course, from $1.74 to $2.155, and for extra binder $11.90 to $12 per ton. The engineer's estimate was $2.20 for

asphalt surface and $12 per ton for extra binder. For reasons which were not of interest from a purely technical viewpoint, the commissioners decided to reject all bids and instructed the engineer to draw up specifications which would admit a larger number of asphalts; in fact, to write *open* specifications. This was done and four projects amounting to about 40,000 sq. yds. were advertised for bids. At this letting four bids were received, and the prices ranged from $1.20 to $1.73 for the asphalt surface, and for the extra binder from $10 to $12 per ton.

At the request of one of the leading firms supplying asphalt, a clause was inserted in the bidding blanks permitting the contractors to bid on more than one brand of asphalt. The lowest bidder submitted two bids; one using so-called oil asphalt, and another Trinidad Lake asphalt. His bid for Trinidad was $1.44 per sq. yd. Note that under closed specifications the lowest bid for Trinidad was $1.73. Under open specifications, using the same material, the lowest price was $1.44. Another point which may not be directly attributed to the effect of open specifications the lowest bidder submitted lower prices for what we might call the accessories; that is, curb and gutter, drain tile, manholes, catch basins, etc. All of this meant a great saving to property owners.

Later in the season but before any work had been actually started, the remaining 40,000 yds. was advertised and at this bidding the price for asphalt surface ranged from $1.35 to $1.65 and for extra binder from $10 to $12 per ton. This was all the bidding during the season and about 60,000 yds. was completed, leaving 20,000 yds. for work as soon as the weather permits, in the spring. I have made a tabulation of one of the projects to show the difference in the cost under the various bids received during the season. This particular project contained 14,787 sq. yds. Its actual cost, constructed under price obtained at third bidding, was $36,604.90 or $2.47 per sq. yd. For this tabulation I have taken the actual amount of material used:

Lowest bid, closed specification	$42,147.23
Lowest bid, open specification, oil asphalt	33,652.05
Saving ($0.565 per sq. yd.)	$ 8,495.18
Lowest bid, closed specifications	$42,147.23
Lowest bid, open specifications, Trinidad	36,905.19
Saving ($0.35 per sq. yd.)	$ 5,242.04

The following discussion of Mr. Andrew's paper is by John B. Hittell, Chief Street Engineer, Board of Local Improvements, city of Chicago:

All authorities agree that asphalt originates in petroleum, and there is no difference whether the asphalt occurs in solution and is obtained through a steel pipe, as in Mexico and the United States, or if it exudes through a fissure in the earth in the form of a heavy oil, and is spread over the savannah to a depth of from 2 to 9 ft. and an area of a thousand acres, as in Venezuela; or whether it issues through a mass of fine mineral matter contained in what is presumed to be the crater of an extinct volcano, as in Trinidad.

The dominant requirements of an asphalt cement are that it should be adhesive, cohesive, not vary too much in ductility under different temperature ranges, have permeability under all weather conditions, and otherwise be not affected by the elements. Who can say that the bitumen of any asphalt is superior over the others when these requirements are taken into consideration? In fact, the influence of the kind of bitumen as to its effect upon the character and the stability of the wearing surface has been greatly overrated. Mr. Wallace L. Caldwell, of the Pittsburgh Testing Laboratory, after an examination of the causes of failures of bituminous wearing surfaces, exclusive of failures due to foundations, stated that those due to the unsuitability of the bitumen were but five per cent, the remaining causes being divided among the factors of workmanship, grading of the mineral aggregate, weather conditions, plant operations, and improper ductility.

In contravention of the word manufacture, there is no such article as a natural asphalt. To manufacture means to take a raw material and by some process make it a finished or useful article. The so-called natural asphalts, Trinidad and Bermudez, go through two processes before they can be incorporated in a paving mixture. The first is that of refining wherein the light oils and extraneous materials are driven off as much as commercially possible, and the second when these refined asphalts are fluxed with a petroleum oil to make them into asphalt cements. Asphalts obtained from petroleum go through but one process, namely, that of driving off the lighter oils until the residue has reached the desired consistency.

Service and use, however, to a great

extent determine the value of an article. Since the petroleum oil asphalts are put on a parity with the so-called native or natural asphalts by all the leading technical societies in the United States, every large city in the Union, the state highway departments using asphalt, and the U. S. Bureau of Public Roads, and furthermore, since their consumption is about ten times that of the Bermudez and Trinidad combined, there seems to be no reason why those in authority should not adopt an open specification and reap the benefits of genuine competition, without impairing the quality of the pavement.

THE LEGAL STATUS OF MUNICIPAL COAL AND WOOD YARDS

By Joseph N. Moonan of Moonan & Moonan, Attorneys at Law, Waseca, Minn.

(Editor's Note: The right of a municipality to engage in the retail fuel business has been questioned. A case sometimes cited in support of this contention is that of the State ex rel. Kansas City v. Orear, 210 S. W. 392 (the Kansas City Ice Case) in which an express charter provision authorizing the City to engage in the business of making and selling ice was held to be invalid. Some held that the view of the Missouri Supreme Court is supported by the weight of authority. The question involved was stated in the Opinion in the Missouri case as follows: "May a town or city in this State, its charter permitting, lawfully engage in the business of making and selling ice to the inhabitants of such city?" A Missouri constitutional provision is: "Taxes may be levied and collected for public purposes only." The Missouri Court answered its question with: "No." It is this answer which some contend is supported by the weight of judicial authority. Some hold that it is beyond the power of a municipal corporation to engage in the sale of commodities which are and can be easily conducted by private business concerns in competition with one another, and which can be sufficiently regulated thereby, except during emergencies when a municipal corporation may buy and sell commodities of any sort as an agent for the relief of the community. Those who hold this view believe that a municipality can not legally engage in the sale of fuel to its inhabitants at retail, and that a statute or charter provision authorizing it to do so violates the constitutional provision prohibiting the use of the taxing power for a private enterprise. The author of the present article does not agree that the foregoing contentions are supported by the weight of judicial authority at the present time, and he gives the reasons on which his views are based.)

The question of the right of a city to engage in the sale of coal at retail was first considered by a court in the opinion of the Justices of the Supreme Court of Massachusetts in 1892 reported in 30 N. E. 1142. This and the subsequent opinions of the Massachusetts Court were not decisions but merely advisory opinions not having the force of a decision. From the opinion rendered in 1892 Justice Oliver Wendell Holmes dissented saying:

"I am of the opinion that when money is taken to enable a public body to offer to the public, without discrimination, an article of general necessity, the purpose is no less public when it is water or gas or electricity or education, to say nothing of cases like the support of paupers, or the taking of land for railroads or public markets.

"I see no ground for denying the power of the legislature to enact the laws mentioned in the questions proposed. The need or expediency of such legislation is not for us to consider."

The only case decided by any court which supports the conclusion of those opposed to a municipal coal yard is the case of Baker vs. City of Grand Rapids reported in 106 N. W. 208 wherein the Michigan Court held:

"A municipality, however, cannot enter into a commercial enterprise, such as buying and selling coal to its citizens as a business, thereby entering into competition with dealers in coal. Such use of moneys is held not to be for a public purpose. Opinion of the Justices, 155 Mass. 601, 30 N. E. 1142, 15 L. R. A. 809, and cases cited."

This decision of the Michigan Court has been overruled in principle by that court in a later case of Andrews vs. City of South Haven, 153 N. W. 827. On page 830 of the opinion of that case the Michigan Court said:

"We are past the general question of the validity of legislation authorizing municipal ownership and operation of plants and their necessary equipment to furnish the concentrated population of cities with certain general needs and conveniences, like water, light, heat, transportation, telephone service, etc.; and it is held that

the court will not interfere with any reasonable exercise of the implied powers to operate such plants in a business way, and as any private corporation could or would."

And on page 829 of the opinion the following appears:

"The question raised here relates only to the proprietary or business powers of the city, by means of which it may act and contract for its own private advantage and that of its inhabitants combined. In the exercise of the latter powers, the municipality, acting through its officers, is governed by the same rules which control a private individual or business corporation under like circumstances. Omaha Water Power Co. vs. City of Omaha, 147 Fed. 1, 77 C. C. A. 267, 12 L. R. A. (NS) 736, 8 Ann. Cas. 614. In such case the fact that a city engaging in a certain line of activity, commercial in its nature, competes with and thereby damages one of its inhabitants in his business, does not entitle him to relief, for the city owes him no immunity from competition."

On page 830 of the opinion the court cites with approval the case of Holton vs. Camilla, 134 Georgia, 560, wherein it was held that a city had the right to embark in the business of manufacturing and dealing in ice, and in the decision in the Andrews case the Michigan Court held that the city had the right to sell and install electric light fixtures, bulbs, wire and wiring. The court did not overlook the Baker case because it is cited on another point on page 831 of the opinion but was not considered by the court on the question of the authority of the city to engage in the business. So it will be seen that the court that decided the Baker case does not any longer consider it an authority. This is the only decided case which holds a city cannot engage in the fuel business and this case had never been followed by any other court.

In the case of Laughlin vs. Portland, 111 Me. 486, 90 Atl. 318, 51 L. R. A. (NS) 1143 the Maine Court held that a city could operate a municipal coal yard, saying in part in the opinion:

"Let us look at the question from the practical and concrete standpoint. Can it make any real and vital difference and convert a public into a private use, if instead of burning the fuel at the power house to produce the electricity, or at the central heating plant to produce the heat, and then conducting it in the one case by wires and in the other by pipes to the user's home, the coal itself is hauled over the same highway to the same point of distribution? We fail to see it. It is only a different and a simpler mode of distribution, and, if the legislature had the power to authorize municipalities to furnish heat to their inhabitants, 'it can do this by any appropriate means which it may think expedient.' The vital and essential element is the character of the service rendered, and not the means by which it is rendered.

"But it is urged: Why, if a city can establish a municipal fuel yard, can it not enter into any kind of commercial business, and carry on a grocery store, or a meat market, or a bakery? The answer has been already indicated. Such kinds of business do not measure up to either of the accepted tests. When we speak of fuel we are dealing, not with ordinary articles of merchandise, for which there may be many substitutes, but with an indispensable necessity of life; and, more than this, the commodities mentioned are admittedly under present economic conditions, regulated by competition, in the ordinary channels of private business enterprise. The principle that municipalities can neither invade private liberty nor encroach upon the field of private enterprise should be strictly maintained, as it is one of the main foundations of our prosperity and success. If the case at bar clearly violated that principle, it would be our duty to pronounce the act unconstitutional, but, in our opinion, it does not. The element of commercial enterprise is entirely lacking."

In Jones vs. City of Portland, 113 Me. 123, 93 Atl. 41, the Maine Court again upheld the validity of the municipal coal yard act. In Jones vs. City of Portland, 245 U. S. 217, 38 Sup. Ct. Rep. 112 the United States Supreme Court affirmed the Maine Court saying:

"The authority to furnish light and water by means of municipally owned plants has long been sanctioned as the accomplishment of a public purpose justifying taxation with a view to making provision for their establishment and operation. The right of a municipality to promote the health, comfort, and convenience of its inhabitants by the establishment of a plant for the distribution of natural gas for heating purposes was sustained, and we think properly so, in State of Ohio vs. Toledo, 48 Ohio. St. 112, 26 N. E. 1061, 11. L. R. A. 729. We see no reason why the State may not, if it sees fit to do so, authorize a municipality to furnish heat by

such means as are necessary and such systems as are proper for its distribution. Heat is as indispensable to the health and comfort of the people as is light and water."

In Stevenson vs. Port of Portland, decided in 1917, 162 Pacific 509 the right of the city of Portland to sell coal to ships was involved and the Oregon Court held that the sale of coal by a city was a public purpose saying:

"Custom and usage may be important factors in determining whether a tax is for a public or private purpose; but, while recognizing the influence of customs and usages already established, the courts are mindful of the fact that new customs may be formed and new usages may prevail, and that conditions may change as time advances, so that a purpose which was concededly private a decade ago may now be public and so, too, those which today are admittedly private purposes, tomorrow may be public in their nature."

In the cases of Green vs. Frazier, 176 N. W. 11, (North Dakota), Green vs. Frazier, 253 U. S. 233, Scott vs. Frazier, 258 Fed. 669, all involving the right of the State of North Dakota to build and operate state elevators and flour mills, the decisions permitting cities to operate municipal coal yards were cited with approval and in principle followed.

In Scott vs. Frazier, 258 Fed. 669 on page 675 of the opinion the court said:

"McQuillin on Corporations, Section 1809, and the fifth edition of Dillon on Municipal Corporations, Volume 3, Section 1292, which contain the last word of textwriters on the subject, solemnly inform us that cities cannot be authorized to establish publicly owned coal and wood yards, because that would be using the taxing power for a private purpose. The next edition of these works will strike out this language and inform us that such yards are permissible, because they are for a public purpose and are publicly owned, citing Jones vs. Portland, 245 U. S. 217, 39 Sup. Ct. 112, 62 L. Ed. 252, L. R. A. 1918C, 765, Ann. Cas. 1918E, 600. Thus 'can' succeeds 'can't' in this field of law so rapidly that one can hardly tell which word he is looking at."

In Wheelon vs. Settlement Board, 181 N. W. 358 and State Reclamation Board vs. Clausen, 188 Pac. 538 (Washington) involving the right of states to engage in reclamation and land settlement projects the city coal yard cases where cited with approval and their principle followed.

The basis of the opinion of the Massachusetts Court that a city can not engage in the fuel business is the case of Lowell vs. Boston, 111 Mass. 454, which is the leading authority in this country declaring a statute unconstitutional because it authorized taxation for private purpose.

In 1917 by a popular vote of 261,138 to 52,437 a constitutional amendment was adopted sweeping away this decision. With reference to this Judge Amidon in his decision in the North Dakota elevator case, 258 Fed. 699 on page 677 of the opinion says:

"This was the first time that the reasoning of Lowell vs. Boston was brought to the judgment bar of the people of the State. That decision had stood for more than half a century as an authority supporting scores of decisions nullifying laws to correct evils from which men, women and children were suffering and furnishing reasons to even more congresses, legislatures, and city councils why other laws should not be passed to correct such evils. And now that the real supreme tribunal of Massachusetts, the people of that commonwealth, has swept all these judicial precedents away in that State, what do we say has happened? This:

"The court was right all the time; but the people have now amended their constitution and granted the legislature power to do what the court said they could not do before, and so the legislature may hereafter enact needed laws."

"But does that state the whole truth? I think no. Is it not more true to say that the people of Massachusetts have corrected, if not rebuked, the judges of their Supreme Judicial Court? Have they not really said to their judges:

"You have been wrong all this half century. We never intended those general words in the Constitution to mean what you have been saying they mean, and we wish you would not use them any more to protect practices that have been proven to be economically, morally, and legally unsound. (Ives vs. South Buffalo Railway Co., 201 N. Y. 271-287, 94 N. E. 431, 34 L. R. A. (N. S.) 162, Ann. Cas. 1912B, 156), and nullify laws passed for their correction."

"Is not that the real interpretation of what has happened, not only in Massachusetts, but in the adoption in nearly every State in the Union, during the last 15 years, of constitutional amendments to correct decisions made under the general provisions which forbid a deprivation of life, liberty, and property without due process of law?"

In American Coal Mining Company vs. Coal Commission, 268 Fed. 562, decided by three Federal Judges, an Indian statute authorizing the State to regulate and fix coal prices was held constitutional.

In People vs. Keyes, 201 Pac. 54 coal mining was held to be an industry affected with a public interest.

In the case of Central Lumber Company vs. City of Waseca, decided by the Minnesota Supreme Court, May 19, 1922, 188 N. W. 279 that court held:

"The establishment of a municipal coal and wood yard is a public purpose; and the home rule charter of Waseca, authorizing it, does not violate the State constitution providing that taxes shall be levied and collected for public purposes, nor the Fourteenth Amendment."

In the opinion the court said:

"Economical and industrial conditions are not stable. Times change. Many municipal activities, the propriety of which is not now questioned, were at one time thought, and rightly enough so, of a private character. The constitutional provision that taxes can be levied only for public purposes remains; but conditions which go to make a purpose public change."

The distinction, sometimes attempted to be drawn, between municipal water works, light plants, and heating plants, and a municipal fuel yard, that the former are legal because a special privilege or franchise to use the highways is required for their operation, while the latter, not requiring such special franchise is illegal, is not without support in the authorities, because it is well settled now that a business may be affected with a "Public Interest" in cases where no special privilege or franchise is conferred by the public or required for its operation. State vs. Rogers, 182 N. W. 1005. German Alliance Ins. Co. vs. Lewis 233 U. S. 389.

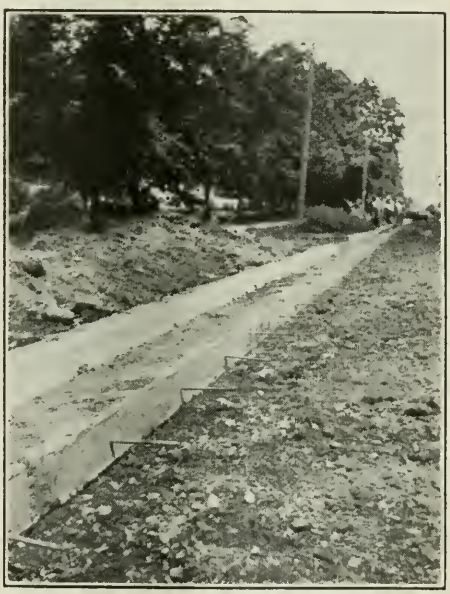
Summarizing the authorities we find opposed to the right of the city to engage in the coal business two advisory opinions, one of them and the earliest one, which formed the basis of the subsequent one, by a divided court. These opinions have been overruled by the people in their constitutional conventions. In addition to these advisory opinions there is one decided case which is not now followed by the court which decided it. Opposed to these are the decisions of the United States Supreme Court and the Supreme Courts of Maine, Oregon and Minnesota, which during the last five years have passed directly upon the question and upheld the right of a city to engage in the coal business. The decisions of these courts have been cited and followed with approval by the courts of South Dakota and Washington and by the other Federal courts.

I think it may be fairly claimed that under the weight of judicial authority in this country the sale of fuel at retail is within the power of municipalities and the establishment of a municipal coal and wood yard is a public purpose.

STEEL BARS TIE COMBINED CURB AND GUTTER TO PAVEMENT AT LIBERTYVILLE, ILL.

By Charles E. De Leuw, of Kelker, De Leuw & Co., Engineers, Conway Bldg., Chicago, Ill.

A reinforced concrete pavement is being constructed on Milwaukee Avenue through the village of Libertyville, Ill.,



COMBINED CONCRETE CURB AND GUTTER OF UNUSUAL DESIGN AT LIBERTYVILLE, ILL. NOTE DENSITY OF CONCRETE AT FACE OF GUTTER AND STEEL TIE RODS TO JOIN GUTTER AND PAVEMENT.

which involves some departures from stereotyped designs of such work. The principal feature of interest is the concrete combined curb and gutter; the curb and gutter is being constructed without a mortar finish coat and is tied into the pavement by means of steel tie bars.

Combined Curb and Gutter

For a number of years it has been cus-

tomary to construct the curb integral with the pavement on concrete pavements. This has resulted in some economy and has also strengthened the structure at the edges, due to the increased depth and strength of the beam at each side of the pavement. On the other hand, it has been difficult to secure true line and pleasing finish on integral curb. The gutter has frequently been left with small pockets which hold water and the face of the curb lacks even and true alignment.

The Libertyville curb and gutter was designed so as to permit of its construction in advance of the pavement, following the customary construction of brick, asphalt and block pavements. It is shown in the accompanying view. The ½-in. round bars are spaced on 3-ft. centers and they project 9 ins. into the gutter, as well as the pavement. Holes were drilled through the steel forms to accommodate these tie bars, and no particular difficulty was experienced in removing the forms.

The concrete was of the consistency required by the Illinois Highway Department for concrete pavements. The proportions were also the same as the concrete for pavement (1-2-3½) and no mortar finishing coat was used. The face board was removed about 30 minutes after the placing of concrete and the face and top surface of the curb and gutter given a brush finish. The corners were rounded to a ¼-in. radius with an edging tool. The resulting surface, while not as smooth as can be obtained by using a mortar finish, was quite satisfactory.

Advantages

The principal appeal to the experienced engineer is the substantial nature of this construction. The use of a rich mixture insures a dense, sound concrete of high strength. The elimination of the mortar coat results in one solid structure with the same coefficient of expansion throughout. Improper handling or inadequate mixing is readily apparent and it will be possible no longer for the contractor to cover a lean mixture of poorly mixed material with a rich mortar top.

The use of tie bars makes the curb and gutter to all intents and purposes an integral part of the pavement, thus securing the advantages of the integral curb construction with none of its disadvantages of finish and workmanship. The curb and gutter will move laterally and vertically with the pavement, and there will be no displaced curb and gutter after a few years' time as a result of frost action.

Detailed cost records on this construction are being kept so that an exact comparison can readily be made between the cost of this curb and gutter and the two-course type. The following is a typical daily cost report on curb and gutter:

DAILY REPORT OF INSPECTOR

June 22, 1923 Job. No. 239

Class	No.	Hrs.	Rate	Tl. Pay
Form Setter	1	10	$0.90	$ 9.00
Form Setter Helper	2	20	0.60	12.00
Engineer	1	10	0.90	9.00
Finishers	3	30	0.60	18.00
Foreman	1	10	1.00	10.00
Laborers—Oiler	1			
Wheelers	6			
Tampers	4			
General	5			
		160	0.60	96.00

Total Labor Cost.....$154.00
Cement, total, 39 barrels.
Per lineal foot, .090 barrels.
Progress—434.5 lineal feet of curb and gutter; labor cost per lineal foot, $0.355.

It is apparent that the cost of this structure is about equal to the cost of the familiar two-course curb and gutter. The labor cost on the entire job averaged 35.7 cts. per lineal foot of curb and gutter.

James Cape & Sons of Racine are the contractors on the work, which is being constructed under the supervision of L. H. Cather, resident engineer for Kelker, DeLeuw & Company of Chicago.

IODINE TREATMENT OF A PUBLIC WATER SUPPLY FOR PREVENTION OF GOITRE

By Beekman C. Little, Superintendent of Water Works, Rochester, N. Y.

(Editor's Note: This very important article was presented as a paper before the recent annual meeting (May, 1923,) of the American Water Works Association, of which Mr. Little is a past president. Those interested in other articles on the iodine treatment of goitre are referred to the bibliography in the Journal of the American Water Works Association for July, 1923).

The statements to be made concerning the particular malady discussed in this paper have been gleaned from the writings and opinions of others than myself, for I know little about the cause or treatment of goitre.

The Water Bureau and the Health Bureau of Rochester, working together, believe they have evolved a plan for successfully treating and preventing goitre. With great emphasis on the latter: for *prevention* is the ideal we seek.

Having great faith in the idea, I desire to launch it here at this convention and to have the American Water Works As-

sociation broadcast it to the world. It is earnestly hoped, therefore, that you will bring the matter before the health officers and medical associations of your respective communities.

Simple goitre is a disease which has probably come to the attention many times of every one here. It is generally recognized as a swelling of the neck due to the enlargement of the thyroid gland. The extent to which goitre prevails is seldom appreciated. In the entire world there are few countries free from goitre districts and sporadic cases of goitre exist in every section and nationality in the world.

In North America, goitre is endemic, especially and continually prevalent in the whole of the Great Lakes region and in the basin of the St. Lawrence and in the northwest Pacific region.

The seriousness of the disease itself may be learned with little investigation. There is a relation betwen goitre and cretinism or idiocy, marked by physical deformity and degeneracy.

Statistics are not always reliable, but it is safe to say that in this region along the Great Lakes, in Detroit or in Rochester, 7 out of every 100 school children are afflicted with goitre. In addition, a large proportion of all the women who consult physicians have the disease.

Certainly this is a disturbing condition and any promising suggestion for its alleviation should receive at least attention.

Iodine is a natural constituent of the normal thyroid gland. It is essential to normal thyroid activity. The amount of iodine required is exceedingly small, but, when this amount is absent, the thyroid gland seeks by increase in size and surface to make up for this lack in iodine, and goitre is the result. In fact, goitre has been described as an adaptation to "iodine-deficient" nutrition. It follows, therefore, that the treatment for goitre, now pretty generally practiced, is the giving of very small dosages of iodine. The small amount of iodine now considered necessary is indicated by the fact that 1/10000 of a gram of iodine taken daily over a period of 15 or 20 days is an accredited prescription. This dose is given twice a year, once in the spring and again in the fall.

A recent study from the laboratory of the University of Minnesota, by Dr. J. F. McClendon, shows clearly the inverse ratio between the amount of iodine in surface water and the distribution of goitre. In the neighborhood of the sea, the air and water contain much more iodine than in inland places, and these places distant from the sea have high goitre incidence.

What we propose to do is to introduce into our drinking water a very minute quantity of iodine and thus bring to the human system and the thyroid gland that which it needs, and otherwise lacks, to function properly.

This idea of dosing every one willy-nilly is startling but not unknown, so that it is not altogether revolutionary. For instance, in Switzerland, where goitre is prevalent, it was decided last February, in one canton, to incorporate a small amount of iodine in all the table salt used. All civilized persons take daily a certain quantity of salt and, as it is inexpensive and the Swiss government can control this article of food, it seemed to be the proper carrier for the iodine.

This way of doing it, even if it were possible in this country, does not seem to have the advantages of the water supply method.

In the recommendation of our plan in Rochester, Dr. Goler, the Health Officer, states:

1. We always have in Rochester, among our children, more than 2,000 cases of preventable goitre.

2. We have so much simple goitre because of the absence of minute quantities of iodine in our food and drink.

3. We may prevent this goitre by the addition of minute quantities of iodine to the drinking water in the amount of 2/10,000 of a gram to a gallon, in the form of iodide of soda.

4. Iodine seems to be required by the body. When taken into the body in these minute quantities, it is fixed by the thyroid gland and its enlargement, and consequent goitre, is prevented.

5. If we put iodine in the water, it will be necessary to dose the water only twice a year, for two weeks. This would require each day 13.3 pounds of iodide of soda for two weeks, or 372 pounds at $4.80 per pound, or $1,785.00 a year.

6. To prevent goitre would cost less than $2,000.00 a year. The addition of this minute quantity of iodine would also affect favorably young persons already having goitres. It would not affect that form of goitre known as "Graves Disease" or exophthalmic goitre. It would not affect older goitres.

The Water Bureau at Rochester has already started this treatment of the water. At one of our reservoirs, from which is

drawn all of the water entering the city mains, we have dissolved daily—for a period of two weeks—16 lbs. of iodide of soda, a slightly greater amount than first suggested.

Our consumption of water during this period was approximately 25 million gallons per day. In the laboratory of the Health Bureau, and checked up by chemists in the University of Rochester laboratory, accurate check was kept and it was found that the iodine content in the water increased from 1 part in a billion parts of water, before the experiment, to 20 parts in a billion after the addition.

Next fall the dose will probably be increased, as it is planned to get about 50 parts of iodine to one billion parts of water.

It is calculated that such a water, prevailing for two or three weeks, twice a year, will give to those drinking of it freely approximately the amount of iodine needed to bring to a close the story of simple goitre in Rochester.

DELAY IN AWARDING CONTRACTS COSTLY TO CONTRACTORS

By William Russell Davis, Consulting Engineer, 90 State St., Albany, N. Y.

The hazards of contracting are many. This article treats of some actual experiences the author had in connection with the award of contracts. The names of the parties are best omitted.

About ten years ago the writer, acting for contracting clients, prepared a contract proposal for a bridge over a stream dividing two counties in one of the United States of America. The advertisement requesting proposals appeared in the Engineering News, and asked for a lump-sum price. Preparation of the proposal involved a careful estimate of the quantities involved, a study of local conditions including costs of local labor and materials, the collection of quotations for steel cylinders for piers and for steel superstructure, etc. Altogether the cost of preparing an intelligent proposal was quite considerable.

At the time the material market was constantly advancing and quotations were subject to revision in from four to six weeks.

The specifications fixed the number of days for completion with a daily penalty for non-completion within the time limit. The bids were received in May and the author planned for completion before the cold weather of the following winter.

The bid submitted by the author was approximately $80,000. It was low by about $4,000 and contract was awarded promptly by the county where the bids were received but SUBJECT to award by the adjoining county. We were then informed that the officials of that county would not meet until four weeks later. The author was present at the later meeting, when the contract was awarded "subject to the sale of bonds." It was then explained that the financial arrangements would be completed and the contract executed in a few days. However, the matter was repeatedly postponed and about three months had elapsed before the authorities were ready to execute the contract.

During the interval we frequently advised that our work would be thrown into the winter, thus increasing our costs, and that the advances in the material market would have a like effect. When the authorities were ready to sign we submitted original data and our estimates to show that we were entitled to an additional $10,000 on account of the delays. We refused to sign at the original price and requested an adjustment. The authorities insisted that we were obligated to stand precisely by our original proposal and cashed our certified check for $5,000. They readvertised the contract and awarded it for approximately $93,000 as against our revised offer of $90,000.

We applied to the courts and our $5,000 was returned. We were allowed certain expenses, but our lawyers' fees and some other large costs were not allowed. Altogether we were out several thousand dollars in connection with this contract.

In a large city of another State, although the author found no indication of anything amiss, he also had an experience of delay in award in the face of a rising market on account of non-completion of financial arrangements. The contract amounted to over $1,000,000 and the certified check for $20,000 was held and cashed. Again it was necessary to appeal to the courts. Again the court ordered the return of the deposit and again there were some large expenses for which we were not reimbursed.

One more instance is the case of the Department of Public Works of a large State. The proposal of the author was not involved but he was perfectly familiar with all details. The financial ar-

rangements had not been completed and there were several months' delay with a rising market. The contractor refused to execute the contract and his check was held for many months thereafter, although it was ultimately returned without recourse to the courts.

It is of interest to cite an experience of the author in dealing with the authorities of a large city to which he furnished professional services of an expert nature, giving sworn testimony before a legal investigating committee. The administration delayed payment to the end of its term; a necessary ordinance was vetoed by the Mayor on his last day; the new administration was of the other party and was not much interested. It was about two and one-half years after the services were rendered that payment was made without interest. Lawyers, engineers, accountants, etc., were all affected by the delay.

These experiences are or should be of much interest to government authorities, engineers and contractors. Perhaps the authorities do not realize the effect of such delays on the interests of the contractor. They should clearly understand that such delays mean substantial losses and expensive law suits for which, eventually, the public must pay. Before invitations for proposals are issued, all arrangements should always be completed to the point where an award can be made within ten days or two weeks. The engineer who prepares the contract plans and specifications should also keep these matters in mind and use his influence with the authorities to correct the evils herein described.

It is clearly to the interest of the contractor to inquire of the authorities by letter as to whether or not financial arrangements have been completed and whether or not an award may be confidently expected within two weeks after receipt of the proposals. In lieu of a favorable response, he should either refrain from bidding or should attach to his proposal the condition that the proposal will not hold unless the award is made and the contract signed within a specified time. It must be borne in mind that the execution of the contract is the vital issue, as no contractor is safe in proceeding with his work before execution. Even in face of the usual conditions set forth in invitations for proposals, it is not likely that the authorities will reject an advantageous bid with such a condition attached if necessary arrangements have been completed. Should the bid be rejected for such cause, so much the better for the contractor.

THE PRESENT CONDITION OF PRIVATE WATER COMPANIES

By Waldo S. Coulter, Consulting Engineer, 114 Liberty St., New York, N. Y.

In the more important states, private water companies are within the jurisdiction of state regulatory commissions having extremely broad powers. These powers embody rate-making functions and extend even to the abrogation of long-established contracts which a commission may deem inequitable.

In securing increased rates from such a commission, the time element is an important feature. A water company finding itself, for some legitimate reason, unable to secure an adequate return from established rates, must prepare necessary exhibits, apply to a commission for relief, await hearings, present its case at such hearings and await results. Finally, the date on which the new rates go into effect may be many months after the initiation of the matter. Since the decisions of such commissions are subject to judicial review, some consumer may take the matter to the courts. A Supreme Court case may be followed by an appealed case.

The point is that for one reason or another, there is too often a lag of the net return, a fact of which private companies are painfully aware. Can this lag be overcome?

The Sufficiency of Rates

Let us consider the sufficiency of rates. A commission establishes certain rates on the assumption that they will yield a certain percentage rate of net return on the investment. After the rates go into effect, it turns out that they are in practice insufficient to yield the assumed percentage rate of net return. The company experiences a deficit, not perhaps a negative return, or even a deficit below the line of actual confiscation, but nevertheless a deficit in the sense of failing to earn the return which the commission assumed when fixing the rates and which it deemed necessary to encourage the investment of private capital in a public water utility.

The same result may attend increases of the deficient rates, particularly during

a period of rising costs, and this condition may extend over a period of several years. The question arises, can deficiencies below the assumed percentage of net return, during time past, under regulation, be collected by the company? Is a commission, having assumed a certain percentage rate of net return when establishing rates, bound to see to it that the rates actually produce such a percentage of return? We are, of course, assuming that failure to secure the return is not due to mismanagement on the part of the company, but is altogether owing to the rates. A certain State Supreme Court has decided that the company must be reimbursed for deficiencies of this character, and has instructed the state commission to increase rates accordingly. As an appeal has been made from this decision and the case is now pending, I will not attempt to discuss the matter further.

It may be of interest, however, to consider how such deficiencies might be collected. First, they might be capitalized and added to the rate base. The equity of such a procedure is highly questionable, however, and the scheme may be dismissed from further consideration. Second, the rates may be increased, during a given period, sufficiently to make good the deficiency. The amount of the rate increase to secure a given return would, of course, be fixed by the length of the period during which the deficiency was to be made up.

Rate bases are today largely affected by pre-war construction costs. The majority of water plants date from some time before the war and were mostly constructed when prices were much lower than they now are.

Using Present-Day Costs

As to the use of present-day values in arriving at a rate base, most regulatory commissions and engineers are of the opinion that fair value for rate-making purposes should be based on an average that will represent fairly both pre-war and subsequent construction costs. It is true that certain decisions of the Federal Supreme Court, and of state courts, are interpreted by some to mean that undiluted present-day costs are to be used in valuations for rate-making purposes. Today, the practical effect of such a policy would be legalized stock watering. During periods of abnormally high prices the company would win. Present high construction costs may and probably will be followed by lower costs. Water companies are now undertaking extensive betterments at very high costs. Should a policy of using present costs in rate-making valuations, to the exclusion of all others, be permanently adopted, water companies will face a heavy loss on these betterments, should construction costs fall. A fair policy is always better in the long run for everybody.

As capital extensions and replacements are undertaken at present high costs, the weight of pre-war costs, as regards the total investment, tends to diminish. This means that increasingly higher rates will be necessary to care for this condition while present high costs exist.

The Lag of Net Return

Here again the water company must be prepared to encounter the depressing losses brought about by the lag of net return. That is, losses from the percentage rate of net return which good public policy should grant to encourage private ownership and operation of public utilities.

The future outlook is one of continuous struggle to increase rates from time to time to meet the gradually increasing investment value caused by the gradual replacement of pre-war construction at high cost and the abnormal cost of capital extensions.

This, in turn, brings up the difficulty of financing betterments and extensions, which every growing water company is facing today. In many cases it would seem that only some co-operative arrangement would permit companies to undertake new construction. Possibly this could be arranged by securing contributions from water users, with the understanding that they will be granted a stipulated reduction in rates in lieu of interest. The restricted limits of this brief article prevent a consideration of this question, which deserves an article itself.

For State Regulation Regardless of Ownership

A word may be added, however, as to the effect of the rates charged by municipally-owned and operated water plants. Most such plants are adhering quite closely to pre-war or near-pre-war rates. This is because of the well-known failure of many city departments to provide an adequate gross income. The relatively small profit increment received by privately-owned utilities is insufficient to account for the difference. The public invariably compares the rates of munici-

pally-owned plants with those charged by private companies, to the disparagement of the latter.

As a matter of fairness, it seems but reasonable to insist that municipally-owned water works systems should be under the control of state regulatory commissions and subject to the requirements now imposed on private companies.

POINTS OBSERVED IN EXAMINING A MILLION SQUARE YARDS OF CITY PAVEMENTS

By Paul E. Green, Consulting Engineer, 400 N. Michigan Ave., Chicago, Ill.

An examination of approximately a million square yards of pavement of various types laid in 1922 in the city of Chicago, and of a large yardage of earlier construction was made by the writer this spring. A vast amount of valuable information was obtained as to merits and defects of various types of construction. Much of it applies, particularly, to local conditions in Chicago and would be of no interest to readers of this magazine, but some of it is general in character and some of these conclusions are as follows:

Brick Paving

The city of Chicago has laid brick pavements for many years and the material entering into the construction has been carefully tested and the specifications are modern and up-to-date. Inspectors have always been placed on the work during construction and the City's engineers have modified the specifications from time to time as conditions would warrant. Most of the filler used in brick pavement is of tar or asphalt. Many of the alleys, particularly, have used cement grout filler.

Particularly in pavements using a tar filler it is evident that within a short time after the work has been completed, certainly as cold weather approaches, the filler begins to chip out of the joints. The result is that in a year or two there is no filler for a distance of one-quarter to one-half inch below the surface. The edges of the brick are then battered down and the more they are battered, the harder it is on the pavement, as the impact from heavy loads frequently breaks through the foundation. Asphalt filler is more successful in that it does not chip in winter or soften up so freely in summer, but in the course of a few years somewhat of the same effect is apparent. However, it is believed that asphalt filler is superior to tar filler.

In alley pavements where a large amount of cement grout filler has been used, the effect of expansion is very apparent. Many of the alleys are badly cracked and the edges of the brick spalled. The surface, however, is fairly smooth, but spotted with patches of disintegrating blocks.

Concrete

A considerable mileage of concrete pavement has been laid in alleys and a few in streets. In general, these concrete pavements are in good condition, though cracked. Expansion is evident in many places and frequently inadequate provision has been made to take care of this feature. It would seem as if the experience of engineers with brick paving using cement grout filler would have been a lesson in the construction of concrete pavements, but many engineers are still laying concrete pavements, providing for contraction joints, but not providing for expansion joints. The result has been during the past summer that there have been a great many examples of "explosions" in concrete surfaces. The conclusion reached is that provision must be made for both expansion and contraction in the construction of concrete pavements and unless such provision is made, trouble will inevitably follow.

While only 1922 construction was officially examined and reported on, still many thousands of yards of earlier work was observed. It was found that frequently a depression over the connection between the sewer storm water inlet in the gutters and the sewer itself was evident. Rarely was a depression found over the main sewer. In the construction of pavements there are usually many more inlets installed than were placed on the original sewer. The sewer itself may have been built several years prior to the laying of the pavement. Many of these depressions do not show up during the first year, but become increasingly evident as years pass. The lesson to be learned is that greater care is essential in making sewer connections and that many of our rough pavements are rough because of lack of care at the time the inlets were installed.

Concrete Curb

Thousands of feet of concrete curb were examined. Most of the curb consisted of cement limestone concrete. The older curb was of cement granite

concrete. It is believed, as a result of this examination, that the granite concrete is decidedly superior for curb purposes to limestone. It wears better and withstands the grind of traffic.

It was also observed that corners having a small radius, as for instance 2 or 3 feet, were much more affected by expansion in the concrete than were corners having a larger radius, say 6 to 10 ft. This was irrespective of the effects of the traffic turning the corner. Nearly all curb more than a year old, having a small radius, had the corner stone badly distorted or broken. Practically none of the curb corners having a larger radius showed signs of disintegration of this sort.

Bituminous Surface

The traffic on the main boulevards in Chicago is exceedingly heavy, in some cases amounting to more than 30,000 vehicles per day. Nearly all the boulevards are surfaced with mixtures of either sheet asphalt, or asphaltic concrete. A few have bitulithic. During warm weather the asphaltic concrete, in particular, softens up and the oil becomes very apparent on the surface. It is necessary to spread over these surfaces gravel or granite chips in order to keep the roadway serviceable. Much of the asphaltic concrete pushes into waves under intense traffic and these waves are very difficult indeed to eradicate. In the usual course of maintenance an asphalt seal course is spread over the surface and chips rolled in. Under heavy traffic this does very well for awhile, but by the following season much of this surface treatment has been worn away and only patches remain. These patches are very rough.

This condition is not nearly so apparent on the standard sheet asphalt surfaces or on the bitulithic. The mixtures appear to be more stable than asphaltic concrete. It is to be expected as the ingredients are more carefully graded.

The lesson to be learned in this examination was that great care must be taken in grading the mineral aggregates of bituminous pavements, just as great care as is necessary in the preparation of the asphaltic material.

Foundation Troubles

A good many cases were found in which the foundation was apparently shattered. This by no means was the result of too thin a foundation; more generally it seemed to be caused by variation in the wearing surface; in other words the wearing surface was more or less wavey and traffic dropping into the low spots caused very heavy impact stresses to be set up in the foundation, which in time on heavy traffic streets, with the trucks keeping close to one line of traffic, caused failure of the foundation. This result may be obviated to a great extent by more careful rolling and grading of the surface. It is largely a matter of workmanship.

MAINTENANCE AND REPAIR OF CITY PAVEMENTS

By Willis D. P. Warren, Consulting Engineer, Millikin Bldg., Decatur, Ill.

Considering the fact that we now have a character and volume of traffic entirely different from that of a few years ago, and considering the further fact that municipalities today are finding the expense of various public improvements more difficult to meet, it is believed that the attention of the engineering profession and of interested officials and property owners should be directed to the economy which is possible where city pavements are properly maintained and repaired.

When it is recalled that our State Highway Departments consider maintenance as of first importance, and further, that state maintenance begins shortly after construction, and continues without interruption thereafter until such time as it is found proper to entirely resurface or rebuild, it is difficult to understand just why municipal officials have been so slow in comprehending the tremendous loss involved in the neglect of their pavements.

Typical Example of Neglect

As a typical example of the situation which exists in many cities, it might prove of interest to refer to Decatur, Illinois, which is generally considered and is, as a matter of fact, a live and progressive community. As we have here an investment of approximately $5,000,000 in pavements, and as our population is approximately 50,000, it may be seen by a little computation that the investment in city pavements throughout the country is one of substantial magnitude. The situation in Decatur is simply that where the Street Department has an appropriation of from fifteen to twenty thousand dollars a year for the maintenance and repair of old pavements, it should have an appropriation of prob-

ably $100,000 or more, per year, especially so, since we have what might be termed "deferred maintenance," inasmuch as our pavements have received little, if any, maintenance since their first construction.

The plea has been made here as elsewhere that the City has no funds with which to make ordinary repairs, whereas under certain legal proceedings they can entirely rebuild a pavement or resurface it, assessing the cost against the property especially benefited; therefore, repair and maintenance are practically unknown. The points which it is desired to emphasize in this article, are as follows:

Maintenance and Repair Fundamentals

(1) Repair should begin on city pavements immediately after their construction, and continue thereafter under proper supervision and direction, until such time as resurfacing or renewal are found to be more economical.

(2) Where there exists a considerable yardage of old pavements, or where pavements have been in service a number of years, exhaustive surveys, studies, investigations and reports should be made concerning the condition of such pavements, and recommendations made as to the proper methods of their repair, maintenance or reconstruction.

(3) No pavement should be entirely resurfaced, unless a careful survey and estimate has been made to show that such resurfacing is more economical than repair. The complete resurfacing of pavements is frequently as great a waste as is the failure to provide ordinary repairs.

(4) No pavement should be entirely removed and a new pavement constructed, unless careful surveys, studies and investigations showing that such construction, considered over a period of years, will be more economical than resurfacing.

(5) Municipal thrift should be encouraged by pointing out to property owners and officials, feasible methods of financing such maintenance and repair.

The conditions at Decatur are not at all unusual, and are not due to special neglect on the part of any particular official or officials, but more to the fact that property owners have not been properly informed regarding the tremendous waste involved in permitting pavements to be thus neglected.

Proper Maintenance

It is true, no doubt, that pavements on state highways, ordinarily have less traffic and less abuse than pavements on city streets, and inasmuch as it is considered sound business by the people of the state to finance highway pavement maintenance and repair, it is certainly much more essential that city pavements should be given the same consideration.

In order that city pavements may have proper maintenance, and that property owners may feel disposed to vote necessary funds for such work, it is believed that, in general, all maintenance and repair work should be done under the direction of the engineering department for the city.

The point really to be considered is that we can no better afford to neglect the repair and maintenance of our city pavements, than the state can neglect the repair of its highways. With this fundamental proposition in mind, it should be endeavored by every possible means to secure necessary funds with which to finance proper repairs.

Surveys and Investigations

It is really surprising, when we consider the thought and care with which engineers and architects develop designs for improvements costing one hundred thousand dollars, more or less, and yet at the same time, with less than an hour's investigation or study, engineers frequently decide that a pavement should be entirely resurfaced, or that it should be entirely removed, and a new pavement constructed in its place.

In this connection it should be remembered that the repair of each type of pavement presents a special problem, and that pavements under different traffic conditions, present different problems. Any pavement which has carried traffic over a period of years, has undoubtedly reached a firm and substantial foundation and is in condition to support and distribute the weight of traffic probably as well, if not better, than a new pavement, provided the irregularities in the surface be once removed.

From our knowledge of old brick pavements, we believe that a large per cent of such pavements might be placed in proper condition by relaying a portion of the surface with new brick, or where in a more serious condition, by taking up the present brick wearing surface, laying a sand Tarvia or other proper cushion, turning the brick and relaying them to a true surface, adding such new brick as is necessary. Upon close study

and investigation it will frequently be found that where a street may sometimes appear to be almost impossible of repair or maintenance, due to the settlement of a portion of the pavement over old excavations, or due to the unusual wear which has occurred on portions of the surface, that probably not over five to ten per cent of the surface is in bad repair.

Also our concrete, wood block, asphalt and other pavements, present their special problems; however, it is believed that the life of such pavements can be greatly prolonged, provided they receive proper attention.

An important point to be borne in mind is that sooner or later the property on any particular street will either be assessed for a new improvement or for the maintenance and repair of the present improvement, and when it is considered that the life of many pavements can be more than doubled by proper and timely repair, the value of such work can be more thoroughly appreciated. In the judgment of the writer the property owners of the City of Decatur, will sacrifice several hundred thousand dollars in the next few years unless funds are raised for proper pavement maintenance and repair, and such work undertaken immediately under the direction of the engineering department for the City.

Financing

In suggesting the value of such maintenance and repair, it will not be amiss to point out methods whereby funds may be derived to carry out this work. Inasmuch as there are several sources from which finances may be secured, it is thought desirable to indicate a few of those which come to mind at this time.

(1) General Municipal Funds. From the general municipal funds most cities set aside a certain amount for street pavement, repair and maintenance, the amount, however, thus set aside being generally sufficient to take care of only a small portion of the work to be done. Considering the case of our own City, where approximately $800,000 is appropriated annually for general municipal purposes, it will be interesting to note that the amount appropriated for street maintenance and repair is very little over 2% of this total, and this in a city where we have approximately 5,000,000 invested in pavements which have had no substantial maintenance or repair since their first construction.

(2) Wheel Tax or Vehicle Tax. In many cities a Wheel Tax may be voted, the funds to be derived therefrom to be used for the purpose of street maintenance and repair. Such a tax is undoubtedly fair for the simple reason that the man who uses the vehicle, and who desires a good pavement, is required to assist in financing its maintenance.

(3) New Legislation. Considering the volume of maintenance and repair work to be done in many of our cities, in view of the past neglect of pavements, it might be well to enact legislation which would enable cities to raise funds with which to organize and finance proper pavement maintenance and repair.

(4) Co-operation. It has been the experience of the writer that where a public official, authorized to care for certain pavements, fully appreciates his responsibilities, and where he has the vision to see the need for repair work, he can frequently finance the same by organizing interested property owners, and by securing their co-operation in raising necessary funds.

The vital fact to be kept in mind in undertaking the financing of pavement maintenance and repair is the economy of such work, as compared to the great expense for resurfacing or rebuilding. As a matter of fact, funds properly invested in maintenance and repair work will return dividends far in excess of funds which might be invested in any form of new construction.

Conclusion

In conclusion, it is desired to emphasize the fact that we now have hundreds of millions of dollars invested in city pavements, which have reached an age where they must be repaired, maintained, resurfaced or entirely renewed. Also it is desired to emphasize the fact that we have new traffic conditions, making it far more essential to do such maintenance and repair work than it was under the conditions of traffic five or ten years ago.

Comparatively few people appreciate the fact that over 95% of all concrete pavements have been constructed during the past 10 years, and probably still fewer realize that most brick pavements have been constructed during the past 20 years. With this knowledge it will be more readily understood that we have reached a period wherein greater consideration must be given to the scientific study, investigation and design of pavement repairs, maintenance and renewals.

When we consider the vast amount of

data which has been collected during the past few years relative to the strength of pavement slabs, impact forces, and the proper design of pavements of various types, it may be seen that unusual opportunities are offered for the application of this new knowledge, in the solution of our present important problem. An examination of current engineering literature will disclose the fact that very little space has been devoted to a discussion of the economics of city pavement maintenance and repair, and further examination will disclose the fact that with the possible exception of one or two books, which discuss the subject more or less briefly, there has been nothing comprehensive written regarding the science of this important subject. It is believed that municipal engineers and research organizations may profitably turn their attention for a time to a study of the economics of city pavement maintenance and repair, and to a campaign of education, which will bring to the attention of property owners the immense waste under existing conditions.

WATER FOR PRIVATE ESTATES

By Louis L. Tribus of Tribus & Massa, Consulting Engineers, 15 Park Row, New York, N. Y.

One of the results of the gathering of great wealth in this country is the development of extensive private parks to surround the palatial homes of their owners; homes which, except for size, have no rivals among the palaces of the Old World.

The engineer who designs a water system for a municipality can deal with average quantities and what might be considered normal use; he who serves the needs of these private estates has little but the whim of the owner as a guide to the quantity of water to be supplied.

It may not be uninteresting to present some notes from a recent development, in our firm's charge.

The estate consists of some 900 acres: 250 kept as the Owner's Park, the balance as farm and pasture. Two persons constitute the family, and from 65 to 90 outside employes the operating staff, plus the household and garage retinue. The owner occupies the property scarcely over four months a year, yet everything must be kept in perfect order, to be ready for visits without notice at any time.

Many features of the estate would be interesting to write up, but the water matters alone are to have attention here.

The farm group, a complete model small town, has its own springs, electric pumps, ornamental water tower, and distribution system, but of rather low pressure, so a set of fire mains and hydrants has been installed, served from the estate's main pumping station, ¾ mile away, supplying water at 135 lbs. pressure.

At the main station, water had been taken from a spring reservoir and some 20 shallow wells driven in a gravel stratum, yielding together some 150 or so gallons per minute, and pumped with electric and gasoline pumps through an extensive 4 and 6-in. pipe system to an elevated tank holding about 60,000 gals.

With the addition, however, of a great combination building housing recreation rooms, tennis court, and large swimming pool, for all the year round use, hence abundantly heated, more water was thought necessary, particularly as several acres of additional fine lawns have been added to the previously intensively cultivated area.

The inevitable—three deep wells have been recently driven, one about 600 ft. in rock, one about 500 ft., and one 300 ft., taking water partly from the rock and partly from overlying gravel.

The yield, some 400 gals. per minute, drawn up by electrically-driven deep-well pumps, is discharged into the spring reservoir, converted into a 35,000-gal. tank.

Two 500 g.p.m. electrically-driven centrifugal pumps draw from the reservoir and discharge into the elevated tank, and soon into a new 320,000-gal. 33-ft. diameter steel standpipe.

In short, a supply of about 800,000 gals. per day is provided for two people and their visiting friends, though of course it must not be overlooked that probably 40 or 50 employes living on the properties are also served with food, water and ice. The ice plant has capacity of 4,000 lbs. per day.

How can this water be used?

All normal and abnormal purposes in mansion, garage, stables, farm buildings, laundry, ice plant, swimming pool (55,000 gals. each time filled), fountains and pools (emptied every two weeks), many greenhouses, with steam heating and power plant, etc., and a dozen or more lawn sprinklers, always playing in hot weather.

Electric power, light and telephone cur-

rents are carried in underground cables, much of it in fibre ducts imbedded in concrete.

Surplus waters, from system and storm are gathered as quickly as possible and carried away underground, so as neither to entail surface damage or nuisance. Part of the electric current is generated on the estate, but most of it is purchased.

This development is typical; few small towns in the vicinity of such properties could supply such requirements, and only long purses could meet the costs.

COMMENTS ON WATER PURIFICATION PLANT DESIGN AT WARREN, OHIO

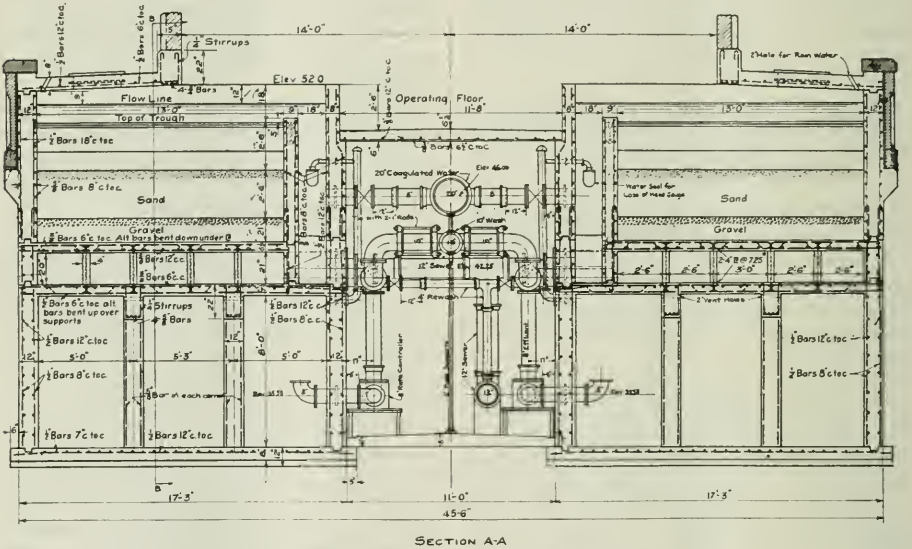
To the Editor:

I refer to an article appearing in your May (1923) number under the caption of "Construction and Operation of Warren (Ohio) Water Purification Plant," by S. N. Vance, Resident Engineer for Alexander Potter, Consulting Engineer, New York City, and P. J. O'Connor, Superintendent of Filtration, Warren, Ohio, and especially that paragraph referring to a plant which was designed by us which reads:

"Unfortunately the plant was not so designed that it could be added to sufficiently to become a big plant; therefore it could not provide but for a short time for the increasing demand for water, for both industrial and commercial uses. The size of the units were entirely too small, as a big plant with small units is very expensive to operate. In addition to this big handicap, the back half of each unit was covered with a low flat roof, which touched the water. The ice formation was therefore bad and in a very awkward place to remove. The coagulating basins were not covered and the ice formation caused the wall to crack."

On which my first comment is that it is a pity that Mr. Vance could not have had before him the article appearing in the same number entitled, "Specific Principles of Good Professional Conduct for Engineers," the sixth paragraph of part one of which reads:

"He (the engineer) should avoid any questionable statements or any statements couched in language that would convey a false impression, in any of his reports, advertisements or articles."



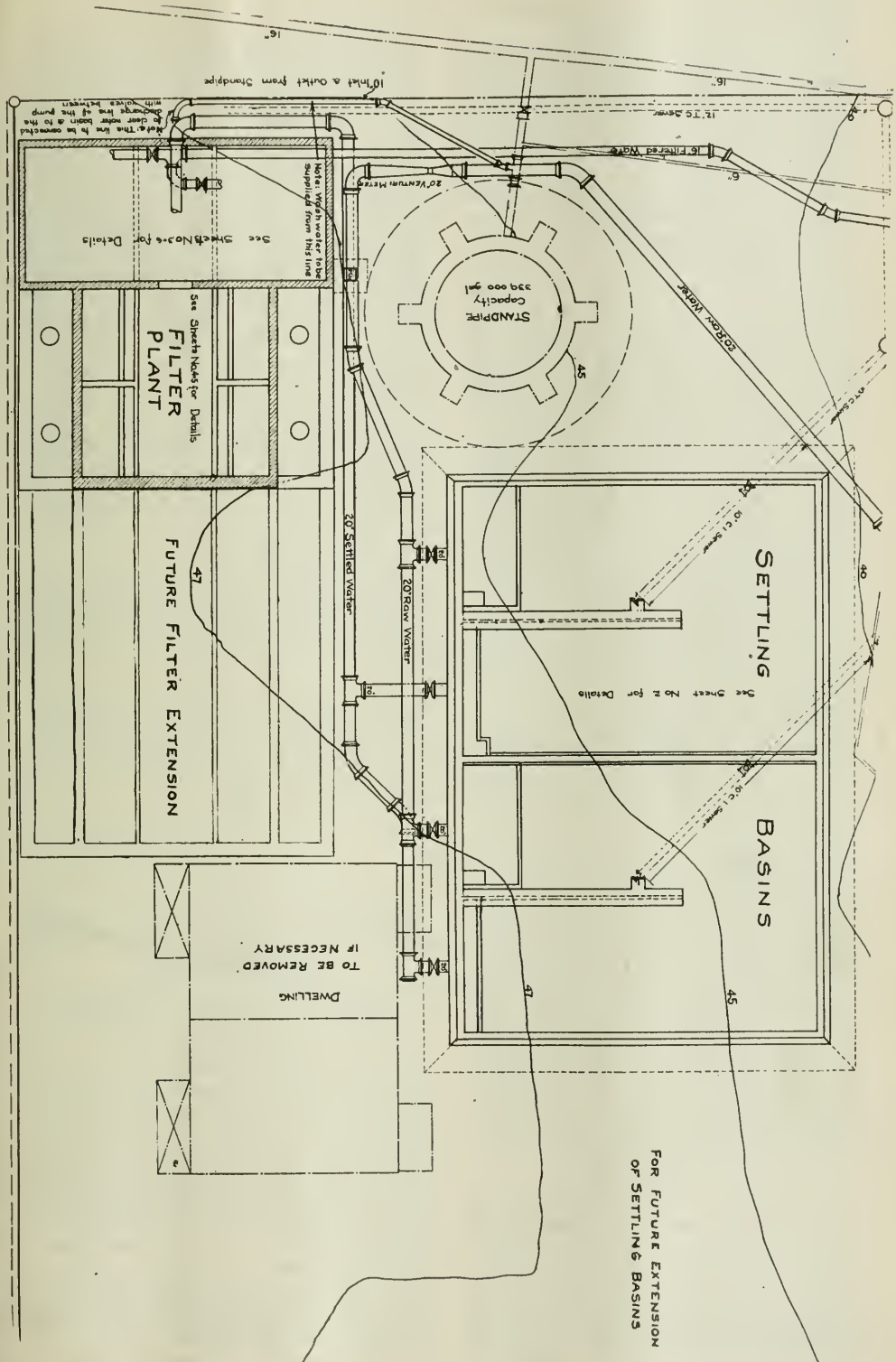
SECTION A-A

CROSS SECTION OF CHESTER DESIGN OF WATER FILTERS AT WARREN, OHIO, SHOWING FLOW LINE CLEARANCE

Contrary to which, Mr. Vance, completely disregarding facts, states that:

"Unfortunately the plant was not so designed that it could be added to sufficiently to become a big plant."

Contradicting this, we submit the plan herewith which shows a dwelling that was removed and from the faint lines you will note, at the time this drawing was made, means for extending it from a two-million or a four-unit plant to a six-million or twelve-unit plant were indi-



LAYOUT OF CHESTER DESIGN OF WARREN (OHIO) WATER PURIFICATION PLANT SHOWING SUGGESTED FUTURE EXTENSIONS

cated, the position of the extended settling basin being shown also.

Please note, too, that the filter plant could be extended indefinitely and as there is other real estate where settling basins could be built, Mr. Vance's statements are surely in gross error. He further states that:

"The size of the units were entirely too small, as a big plant with small units is very expensive to operate."

We should like Mr. Vance to sustain this statement with facts. He further adds:

"In addition to this big handicap, the back half of each unit was covered with a low flat roof, which touched the water. The ice formation was therefore bad and in a very awkward place to remove."

Contradicting this, we submit a cross-section whereon the flow line of these filters will be shown to approach a minimum of 9 ins. of the rear deck and we further submit that the design of these filter tubs is after a standard that has been incorporated in the major portion of all of the concrete filters built to date in the United States and, further, the designers of these plants have designed more than 50 similar plants and have yet to obtain their first experience with ice inside of a properly cared for filter building, or, let us contend that an interior temperature that would freeze ice under this deck would play havoc with the pipe in the gallery. Mr. Vance further continues:

"The coagulating basins were not covered and the ice formation caused the wall to crack."

Since the major portion of the coagulating basins in the United States are likewise uncovered and some attention is expected to prevent ice forming to a destructive thickness, we can only reply that we are still designing and building open settling basins. We are also employing manually controlled valves and feed devices in plants where our clients fail to furnish sufficient money for more expensive and luxurious elements.

Very truly yours,

J. N. CHESTER,

The J. N. Chester Engineers, Union Bank Bldg., Pittsburgh, Pa., June 6, 1923.

(Mr. Chester's letter was brought to the attention of Mr. Vance, who is now in the employ of the city of Warren, and he has written the following reply.—Editor.)

To the Editor:

I am sorry Mr. Chester is offended as I most certainly did not intend to offend. It was our intention to state facts only.

In stating that the plant could not become a big plant our reason was also given; that is, that the tubs of this size would be expensive to operate. We might also have added that the cost of constructing small tubs is expensive, as compared with the larger ones. I note that Mr. Chester states that the plant was designed with a view of a possible extension of from two to six million, or a twelve-unit plant. That is very nice, but even at this it most certainly would not be a big plant. I feel that there is no argument along these lines.

As to the 9 ins. between the water line in the tubs and the decking above, this no doubt was based on a normal rate of filtration, but with 100 per cent over rate there was no space and there was an ice formation, but with none of the pipe in the gallery freezing.

The coagulating basin not being covered was not mentioned as a criticism but what we believe to be the cause of the concrete walls cracking. The ice formation on the basins has been as much as 4 ft.

In a two-million gallon plant of four units, manually controlled apparatus is of course proper. The apparatus is all small and can easily be operated and at no great loss of time.

Very truly yours,

S. N. VANCE,

Warren, Ohio, July 30, 1923.

MUNICIPAL RECREATION IN THIS RESTLESS AGE

By Eugene T. Lies, Special Representative, Playground and Recreation Association of America, 21 N. LaSalle St., Chicago, Illinois.

No very acute perceptions are needed to enable anyone to see that we are living in a restless age. The signs of it are on every hand. A four year, world wide debauch of man-killing could leave no other effect in its wake than an International Pounding Headache and a confused wonderment as to whither we are drifting, whether toward the millennium or toward chaos.

The unity of marshalled forces has given way to the centrifugal scrambling of groups and individuals.

Youth of our day is asking searching

questions of the elders as to the very purpose of life. It is casting aside old sanctions, it is hammering away at what many declare to be the very ramparts of civilization. It is fed on wonders from infancy up and is ever praying lustily; "Come on, give us this day, our daily thrill."

The one hundred thousand youthful delinquents who go through our courts yearly and the existence of three hundred thousand adult professional criminals in the United States, are further indications of the fact that we are a "restless people." Our crime bill runs up to at least a billion and a quarter dollars per year.

In industry, the almost universal use of the automatic machine, which calls not for brains but only for muscular dexterity on the part of the worker, is destroying creative ingenuity and producing revolt in great numbers of toilers, who necessarily, therefore, demand all kinds of excitements as a means of spiritual compensation.

The sudden change from a national wet to a national dry or rather "near-dry-era," is undoubterly figuring in the restlessness of our time and it behooves us to apply effective substitutes for producing those human satisfactions supposed to have been supplied by King Alcohol.

Again, alienists are crying out louder than ever before to us Americans, that we are living too fast in this complex age and that we must either get into lower gear or be prepared to build evermore sanitariums and asylums to take care of the increasing number of nervous wrecks. The abnormal people of all types, now in public institutions, are already costing the taxpayers over $3,000,000 per year.

It is clear enough from the evidence at hand that what we need in our beloved America, is a widespread application of such influences as will steady and upbuild human life and satisfy legitimate deep instincts of our people. In self-expressive recreation can be found just such influences. For the child play is creation. Deprive him of it and you check normal growth and ability to meet the distracting, downpulling tendencies of our strenuous era. For the adult play is recreation. It makes him over, mellows him and prolongs his life.

Commercialized amusements, together form our biggest industry and unfortunately absorb too much of the leisure time of the people; 74,000 persons attended the opening of the base-ball season in New York. Nearly 20,000,000 go to the movies every day and while we do not oppose wholesome profit-making amusements, we do point out that, in view of prevailing conditions, the great need of the hour is for self-participation "in the game." Muscles shrivel for want of exercise: get out on the vacant lot and bat the ball and run the bases. The craving for happy companionship, improperly satisfied, can lead to the morals court or if wholly unsatisfied, to the asylum: get into the social center or the neighborhood club and have that jolly good time. The inner demand for a chance to create something beautiful, if quenched, means irritation and possible outbreak: go where they sing together, get an instrument, though it be only a mouth-organ or ukelele; buy a box of paints and start something; or contrive to get a part in that play or pageant they are putting on at your church.

The Playground and Recreation Association of America is trying to arouse the leaders in the church, the school, the women's organizations, parent-teacher, labor and commercial bodies, as well as the public officials, to the tremendous possibilities in the field of recreation for meeting some of the needs of our time, especially now when there is more leisure to dispose of than ever before in our history on account of the eight-hour day and the prevalence of labor-saving devices.

The organization which I represent is ready, with its 17 years of experience, to help cities and towns to understand their play needs, formulate community programs for leisure-time activities, in which all organized groups can have a part. The results will be more parks and playgrounds, larger use of the schools during evening hours and of the churches and clubs as community centers, wider service by the Y. M. C. A., Y. W. C. A., Boy and Girl Scouts, etc., thus promoting health, happiness, morale and satisfaction of all the people. Crime will be nipped in the bud. The loyalty of the people to their home town will be stimulated. Much of the "wreck" will be taken out of recreation and more "unity" will be put into the community. The city without a play program, as part of its municipal plan, is like an ostrich with its head in the sand. It fails to see its danger. It is pleasanter to pay a recreation bill than a crime bill—and so much cheaper. In this field lies not only a responsibility of first rate importance for our public officials but

also an opportunity of the richest imaginable sort.

The foregoing is a resume of an address by Mr. Lies before the League of Wisconsin Municipalities on June 12, 1923.

A GRAVITY WATER SUPPLY FOR WELLSVILLE, OHIO

By W. J. Sherman, Consulting Engineer, 302 Produce Exchange Bldg., Toledo, O.

Wellsville, Ohio, is a city of 9,000 population, situated on the right bank of the Ohio River, 50 miles below Pittsburgh. It has always depended on the Ohio River for a water supply. In quantity, it was and is never-failing, but the quality has been retrograding steadily with the rapid industrial growth of the Pittsburgh District.

The agitation for a better water supply for this City has been going on for more than ten years. Meanwhile, reports from engineers have been submitted from time to time and consideration has been given to the following sources of supply, to-wit:

(a) A filtered supply from the Ohio River.

(b) A purchased filtered supply from East Liverpool, four miles up the river.

(c) A drilled well supply with wells located along the river bank near the existing pumping station.

(d) A supply from Little Yellow Creek with a pumping station and filter plant.

(e) A gravity supply from an impounding reservoir, located in the Valley of Little Yellow Creek, a small stream discharging into the Ohio River within the city limits.

Inasmuch as all five of these projects would furnish water requiring either filtration or softening or both, the problem naturally resolved itself into one of relative dependability and relative economy in initial cost and cost of operation.

Without going into the advantages and disadvantages of these several projects at this time, we may say in brief that the gravity supply easily won out on its merits and in due time was given official endorsement. Plans were prepared and approved by both City and State. Bids were received on Feb. 14, 1923, on what may be termed the 1923 project, which did not include filtration, for lack of available funds. Contracts were awarded as follows, largely on a unit price basis:

Cast Iron Pipe—The United States Cast Iron Pipe & Fdy. Co.	$ 56,029.40
Valves, Valve Stems and Floor Stands—The Ludlow Valve Mfg. Co.	2,472.47
Pipe Laying—The Allison-Harris Construction Co.	53,428.20
Reservoir and Dam—A. W. Hinaman	110,332.97
Total amount of award	$222,263.04

The above figures represent the summary of costs, based upon the application of the unit prices of the successful contractors to the preliminary estimate of quantities as determined by the engineers. We believe it is generally conceded that the unit price basis is more satisfactory to the city and its engineers because of its flexibility, besides being safer in all respects for the contractor. The city pays for what it gets and the contractor is paid for what he does. The elements of doubt and uncertainty are largely eliminated.

The 1923 project, so-called, includes a reservoir, an earthen dam and the cast iron pipe conduit, leading down to a connection with a distribution system of a municipal water works.

A later project will include a modern mechanical filter plant, which will not in any respect interfere with the gravity features of the present project.

The reservoir with an impounding capacity of 140,000,000 gals. and a drainage area of 16 sq. miles, is expected to provide sufficient storage to meet all requirements of the City for many years to come.

In the design of the earthen dam and the spillway in connection with it, the engineers were fortunate in having access to the United States precipitation records in this vicinity, covering continuously a period of 40 years. The season of minimum precipitation (28.02 ins.) was naturally used in determining the storage capacity of the reservoir and the minimum available run-off from the drainage basin. The season of maximum precipitation (54.98 ins.) determined the dimensions of a spillway and tail race and their elevations.

The flow line of the reservoir will be 243 ft. above the gage at the existing pumping station, 282 ft. above low water in the Ohio River and 225 ft. above the business center of Wellsville, thus according a fairly satisfactory domestic and fire pressure by gravity at all times.

Some of the features of the 1923 project are here summarized as follows:

Reservoir capacity	140,000,000 gal.
Flooded area	26 acres
Mean depth of water	16.5 ft.
Length of spillway	200 ft.
Drainage area	16 sq. miles
Length of dam	450 ft.
Maximum height of dam	60 ft.
Earth work	73,126 cu. yds.
Masonry	1,625 cu. yds.
Dry riprap	6,285 sq. yds.
Grouted riprap	2,048 sq. yds.
30-in. cast iron pipe	300 ft.
18-in. cast iron pipe	1,056 ft.
16-in. cast iron pipe	16,274 ft.

The reservoir is provided with a gate house, controlling the inflow of water from the reservoir at three separate stages and supplying therefrom the main conduit. The gate house is a substantial structure of concrete, circular in form and having an inside diameter of 9 ft., with the operating floor placed 54 ft. above the footings. Hand-operated floor stands control the three 18-in. gates over the inlet port, and one 30-in. gate at the drainage port.

A 30-in. cast iron pipe passes through the base of the dam, serving the double purpose of a water supply for a main conduit and a drain to the main reservoir. Near its lower end is a gate chamber controlling the flow, either into the main conduit to the City or directly into the creek below the dam.

The main conduit passes down the narrow and crooked valley, or rather gorge, of Little Yellow Creek, crossing that stream 15 times en route to a connection with the existing distribution system of the Wellsville municipal water works plant.

At this writing practically all water pipe, valves and special castings have been delivered and all construction operations are well under way.

SOME ACCOUNTING PROBLEMS IN MUNICIPALLY OWNED WATER WORKS

By George C. Mathews, Statistician, Railroad Commission of Wisconsin,, Madison, Wis.

One of the most common misconceptions as to the Railroad Commission of Wisconsin has arisen because of a failure to understand that the Railroad Commission does not establish the policy of the State with regard to the regulation of public utilities. This has perhaps been more true in the case of some of the municipally owned utilities than in the case of those privately owned. Although in general the cities which own utilities have accepted the regulation of those utilities by the State as not undesirable and as leading to desirable results in many cases, the situation has not been entirely free from some feeling that the Railroad Commission was interfering with powers and duties which should be solely within the control of the city administration. The development of the spirit of municipal home rule has seemed antagonistic to control of municipal utilities by the Commission and although the attitude of the cities generally has been one of co-operation and has evidenced a genuine desire to conform to the letter and spirit of the public utility law, it has perhaps been only natural that in some cases there has been a feeling that the Railroad Commission has been interfering with matters of a purely local nature.

I think that this situation is very largely cleared up and that the cities have generally come to realize that the Railroad Commission has no desire to interfere with local affairs and that where it appears that there is interference the Commission is only doing what the legislature has commanded it to do. We must bear in mind that the Railroad Commission is an administrative body and an administrative body only. It has no powers or duties except those which the legislature of the State has commanded it to exercise. It has no more right to fail to do the things which the legislature has commanded it to do than it has to attempt to exercise powers which the legislature has not given it. The legislature, in turn, perhaps not perfectly but at least as perfectly as any system of government permits, expresses the will of the people. The public utility law as originally passed and as amended from time to time represents as nearly as possible what the wishes of the majority of the people of the State are in public utility regulation.

Municipally Owned Plants Have Same Regulation as Privately Owned Plants in Wisconsin

At the time the law was passed one of the important questions which the legislature had to settle was whether the municipally owned utility should be subject to the same regulation as the utility owned by private capital. Wisconsin was not alone in having this problem presented to its legislature. Probably in every state which has laws regulating public utilities the same question was before the legislature. In some of the states the legislature decided that the state would not, through an administrative agency, regulate utilities owned by cities

and villages. In Wisconsin the legislative policy was different. The decision was that municipally owned utilities should be subject to the same regulation as was applicable to private companies. The same provisions of the law regarding rates, service, and practices prohibiting discrimination and requiring uniform accounting, with one very minor exception in the matter of accounting, apply to the municipally owned plants and to the private plants alike. The Railroad Commission does not and cannot go any farther in regulating municipal plants than private plants and, if it performs the duties which it is sworn to perform, it cannot administer the law any less fully with regard to the municipal plants. The policies of regulations have been fixed, not by the Railroad Commission, but by the legislature and by the people of the State. The Railroad Commission is the instrument created by statute to carry out the legislative will. It has no other powers or duties, and consequently when we deal with problems affecting the regulation of municipally owned utilities we must bear in mind that fundamentally we are dealing with policies of the state and that the actions of the commission are only intended to carry into effect those policies.

Governmental and Proprietary Capacities of Cities

Judicial decisions recognize quite clearly that a municipality may and usually does function in two distinct capacities. In administering its city offices, its police and fire departments, in raising taxes, it operates in a governmental capacity. It decides such matters of policy and carries out such legislative and administrative acts of government as it has been empowered to carry out by the State.

But when the municipality enters into the conduct of a business as it does when it operates a public utility there is a general recognition that it is functioning in a different capacity. It has become the proprietor of a business enterprise and functions in a proprietary capacity

Some Phases of Accounting

I have been asked to speak with reference to some phases of the accounting of municipally owned water utilties. I think that it may be best to confine the discussion of accounting matters to such phases of accounting as are involved in the relations between the city as a proprietor and the business which it owns. I think we all recognize that it is fundamental that the proper conduct of any business involves a correct accounting for monies received and disbursed and in some of the activities of the city this may be substantially all that is involved in proper accounting. Where the city enters the conduct of a business, however, it assumes toward that business the same relation which you or I as individuals would assume toward a business which we own and it assumes a relationship toward the business substantially the same as that which the stockholders of a corporation have toward the business which they own. Whether or not the business is successful cannot be judged entirely by whether the cash receipts exceed the cash disbursements. From a financial standpoint the success of the business must be judged by the degree to which it meets all obligations to its proprietor.

The City Equity Account

The account which measures the proprietor's investment, using the term investment in its narrower sense, is the city equity account. This account shows the total of money which the city has transferred from the general fund to the utility. The chief difficulty which we have experienced with regard to this has been due to the failure of the city authorities to appreciate fully the nature of the account. The sources from which a municipal utility derives its capital are in general four:

1. From the sale of bonds which may be either general city bonds or obligations secured by the utility property.
2. By transfer from the general fund of monies in that fund which may have been derived from a number of sources.
3. By the investment in property of earnings reserved to cover depreciation or to provide operating reserves of various kinds.
4. By the investment in the property of earnings which properly constitute a surplus arising from operations.

The Credit Balance

In order to show correctly the relation of the utility enterprise to its proprietor it is necessary that the balance sheet of the utility show correctly the credit balance in accounts representing the sources of funds which are invested in the utility. The city equity account then corresponds to the direct proprietorship account of an individually owned enterprise and represents the investment which the city has made in the utility from its general funds which could have been devoted to other purposes if not invested in utility property.

The Funded Debt

The second balance sheet account which should be stressed is that representing the funded debt whether that debt constitutes a general city liability or is merely a mortgage upon the utility property. In a narrow and strictly technical sense it may appear contrary to good accounting principles to show upon the balance sheet of the utility a funded debt which is a general city obligation. In a narrow sense it might be argued that what the utility balance sheet should show is simply a division of the city equity representing the amount of funds which the city has raised by the issue of general city bonds which funds have been transferred to the utility department. There is, however, a provision of the statutes which provides that before any funds resulting from utility department earnings can be transferred to the general fund, the principal and interest on funded debt must first be met. The effect of this seems to be to recognize the funded debt as an obligation of the utility even though it is also a general city obligation and we have therefore recommended that bonds outstanding, whether simply mortage bonds secured by the utility property or general city bonds issued for utility purposes, should be shown upon the water works balance sheet.

Earnings Reserved

The third source of utility capital which has been mentioned is the investment of earnings reserved on account of the necessity for ultimately retiring the property or earnings reserved for other operating purposes. In some cases city and village officials have questioned the necessity for providing a reserve for depreciation inasmuch as the city could not well, under any conditions, escape its duty to continue the utility business permanently. We have, however, had at least one instance in the State where the city's inability to borrow money prevented for a material time very important changes in its water works system. To some extent at least, the unfortunate results of this situation could have been avoided if a reasonable provision for depreciation or for ultimate retirement of property had been made throughout the operating history of the utility and earnings so reserved furnished one of the sources of capital to that extent relieving the strain on the borowing power of the city. We have also had a number of instances where municipally owned electric utilities have been permitted to get into bad shape and in some cases have been transferred almost without cost to private companies. In such cases the failure to recognize and provide for accruing depreciation has undoubtedly been one of the factors which led to the abandonment of municipal operations.

Confusion Between Surplus and City Equity

In a number of cases where the importance of the city equity account has not been fully appreciated, utility balance sheets have been returned to the Commission showing a surplus out of all proportion to the actual profits which have arisen from operation. That is, the officials have had in mind that where a city had retired its bonds which were issued for utility purposes, there being no longer any evidence of indebtedness against either the utility or the city, that it was fair to throw into a surplus account the excess of assets over accounts payable and depreciation reserve. It is true that there is no instrument evidencing the liability to the city on account of general funds which have been invested in the utility property either directly or through the retirement of such bonds by city funds, but to show as a surplus the excess of assets over accounts payable and reserves gives a misleading impression as to the history of earnings in the utility department. If the city has retired its bonds out of general funds it has in effect increased its own direct investment in the utility; that is, the city equity, and to show as a surplus amounts which should be shown as city equity is unfortunate in accounting because of the incorrect impression which it creates as to earnings. The surplus account should as a general thing show only the surplus resulting from the excess of earnings over expenses of the utility department.

Life of Plant

A utility business, such as the water works business, is a business of indefinite duration. Individual unity of property wear out and have to be replaced or become inadequate and consequently have to be removed, but, so far as any of us know, the business itself will last as long as the locality lasts. Property is used up in the furnishing of water service and unless the books of the water department give effect to this condition they will not properly state the relationship of the utility to its proprietor. The city has put its money into the water plant, the plant is being consumed in public service. The balance sheet of the plant should show as a liability; that is, an obligation to the city, the extent to which there has accrued

a liability to retire property. This, of course, is a more or less indefinite amount since none of us know how long a property will really last, but the difficulty of making a proper estimate does not lessen the importance of making the best estimate that we can nor does it alter the fact that unless the books of the water department show as nearly as can be estimated the extent of this liability they will not correctly reflect the relation of the department to its owner.

Four Important Accounts

So far as conditions on any given date are concerned, therefore, there are four accounts which have seemed to the Railroad Commission of great importance in properly expressing the relation between the city and its utility business. One of these accounts which we have called the city equity should show the direct investment of the city. Another should show the liabilities in the form of debt whether secured directly by utility property or by the general city taxing power. A third account is the reserve for retirement of property, or the depreciation reserve, and the fourth is the surplus or deficit account. Failure to distinguish between these accounts and to recognize properly the amounts which should appear therein means that the true financial condition of the business in which the city is engaged is improperly represented. For a private corporation to send out a statement to its stockholders which would incorrectly represent the relationship of their business to themselves would be a rather serious matter but unfortunately in municipal accounting we have not in all cases reached the point where officials have realized that taxpayers of the municipality should be furnished with as complete and accurate a statement as the stockholders of a corporation.

Accounts Bearing on Results of Operation

I have spoken of the balance sheet accounts which are particularly of interest in reflecting this relationship between the owner and his business as of a given date. In conducting that business during the fiscal period there are certain accounts which are of utmost importance as they have a bearing upon the results of operation. Those of which I wish to speak are:

1. A provision in lieu of local taxes.
2. A provision for the accruing depreciation or the accruing liability to retire property during the operating period.
3. The provision for interest upon the money invested.

In Lieu of Local Taxes

We are often met with the criticism that making a provision for local taxes simply amounts to transferring money from one pocket to another. That is in a sense exactly what is done. Proper accounting is facilitated if the city funds are placed in two pockets—one for general funds and one for utility funds, and unless all of the obligations which are owed either directly by the utility or are assumed by the city on its account are paid out of the utility pocket, the cash in that pocket will incorrectly reflect what has happened in the operation of the utility. When a city buys a water works plant it removes from the tax roll an industry which has been paying taxes to the city. It does not thereby decrease the total amount of taxes which it is necessary for the city to secure and consequently either one of two things must happen, either the taxes on other property must be increased to make up for the loss of taxes in the property acquired by the municipality, or the earnings of the uitility department must be sufficient that there may be returned to the city from those earnings an amount in lieu of local taxes which have been foregone. Some of the cities are actually getting this result, it is true, without placing on their books any account under the name of taxes, but in order that the results of operation may be correctly obtained the burden which is assumed by the city when the water works property is withdrawn from taxation should be placed upon the water works property under municipal operation and definitely measured and accounted for.

Provision for Accruing Depreciation

Since property is used up in operation, customers receiving service at the time of its use should pay enough to protect the city against the loss of that property when it is retired. A great deal of confusion has apparently resulted from the requirement of the uniform classification of accounts regarding depreciation, in that some utilities have understood this to require the setting aside of cash in a special fund. It is the common practice in municipal utilities to retire outstanding bonds serially. Naturally, any provision for creating and retaining an actual fund to meet the cost of replacements has seemed an unnecessary burden and such a fund is not required by the accounting system prescribed by the Railroad Commission. If available funds are used to retire bonds and thus decrease the operations on account of the utility, the financial position of the city and the utility is strengthened

to that extent and provision for depreciation is really made. It is not contemplated that provision for depreciation means the segregation of cash and its retention in a special fund, but it is important that when the cost of furnishing service in any year is stated there should be included as part of that cost the value of the property used up in operations of that year as nearly as can be determined, and the rate schedule under normal conditions should provide for that element of cost as well as for others.

Interest on Obligations

I have spoken also of the question of the interest on obligations. If there are bonds outstanding it is easy to see that interest to be paid on these bonds is a cost of the utility service. If the bonds have been retired, however, it is not always so clear that an element of interest must still be considered in getting at the real cost of service. If you are the sole proprietor of a utility business and if you have retired all indebtedness against that business out of your own funds, you would still hardly consider that business successful unless it paid you the equivalent of interest on your investment. The city is no different in its proprietary capacity than you would be as an individual. The city's utility business is not financially successful even when no bonds are outstanding unless it returns to the city the equivalent of interest on the city's investment. That investment represents a sacrifice by taxpayers of the city and the withholding of that amount of their money from other investments. It is not fair that taxation upon property at the present time or in the past should be utilized to furnish the money for a city business unless that business is to pay interest to the city upon the money so that there will be a return to the taxpayer in the form of lowered taxes in the future.

Value of Services of City Officials

One other point might be mentioned at which municipal accounting has very generally failed to show the cost of utility service. This relates to the value of services furnished to the utility by municipal officials and not charged for on the utility books. It is perhaps more true of the smaller cities and villages than of the larger ones, but in a great many of them some portion of the time of city officials for which salaries are paid out of the general fund is devoted to utility business. The city clerk is often the secretary of the water commission; the city treasurer often does the collecting, yet in many cases the cost of the utility business as stated on the reports of that business does not include any provision for these expenses.

Desire for Proper Accounting Is Increasing

The one simple principle of which we have tried to secure the observance is that the accounting in municipally owned utilities should be such that on any given date the relation of that business to its owner may be properly stated and that for any given period the revenues and the true cost of conducting the business may be correctly shown. To this general statement of the purposes probably few people would take exception, yet the attempt to secure this in municipal accounting has met in many cases with very decided opposition. It should be stated, however, that this opposition is becoming less and less and that in the main the municipalities owning and operating water plants have shown a willingness and a desire to have proper accounting in their utility business. There is one feature of the law which seems to me to be inconsistent with a requirement for proper accounting. This is Subsection C of Section (11) of Chapter 6606 and provides that "The income of a public utility owned by a municipality shall first be used to meet operation, maintenance, depreciation, interest and sinking fund requirements, additions and improvements, and other necessary disbursements or indebtedness. Income in excess of these requirements may be used to purchase and hold interest-bearing bonds issued for the acquisition of the utility or bonds issued by the United States or any municipal corporation of this State or may be paid into the general fund."

Transfer of Utility Funds

This apparent restriction on the transfer of utility funds to the general fund is almost impossible of acurate administration. Nobody can tell in advance just how much of the funds of the utility are going to be needed for additions and betterments and yet if it is not intended that an estimate shall be made of future requirements this section would practically mean that any cash balance could be transferred, which is evidently not its intention. There seems to be no reason why the funds of a utility department, insofar as their payment to the city is concerned, should be subject to different rules or principles than would govern the funds of a business operated by an individual. Sound accounting and sound economic practice should prevail in both

cases but the importance of an artificial restriction is not evident.

The result of this attempt to restrict the city's right to possess itself of funds which are undoubtedly its property has been to promote the feeling that the city and the utility should be considered as entirely distinct organizations. We have had a number of instances in this State where the city has not furnished any money for years for the construction of utility property. Since the law requires that any available utility funds must be devoted to construction purposes ahead of any privilege of transferring them to the general fund, it has not been uncommon for the cities to feel that this meant that the utility should furnish all the funds for its financing and it has been difficult to overcome this impression. It seems to me that a law properly devised to permit the transfer of any true surplus of a municipally owned utility to the extent that that surplus is represented by funds on hand would go a long way toward creating a proper relationship between the city and its utility department and that as long as an artificial restriction is placed upon the transfer of utility funds there is bound to be a tendency for city officials to feel that the utility should furnish all of its funds.

The foregoing paper by Mr. Mathews was presented at the recent annual meeting of the League of Wisconsin Municipalities.

DATA ON THE LIGHTING OF STREETS AND HIGHWAYS

By A. R. Knight, Asst. Prof. of Electrical Engineering, University of Illinois, Urbana, Ill.

The question of lighting city streets is one that has always commanded interest because of the intimate connection between illumination and safety and convenience; and the methods used have been changing constantly. During our own lives we have seen used successively gasoline lamps, gas lamps, various forms of electric arc lamps, and lastly, incandescent electric lamps. Today the incandescent lamp is replacing the other methods, therefore only lighting by incandescent lamps will be discussed in this paper.

Rapid Development of Lighting Units

At no time has any one of the various methods commanded the field long enough to establish itself as the standard method. This has been due partly to the rapid development of lighting units, a development which is progressing as energetically now as at any earlier time, as well as to the constantly changing conception of what is desirable. Until a few years ago comparatively no attention was paid to the esthetic side of street lighting, the idea simply being to have more or less illumination supplied. At present, the matter of general appearance is given practically the same weight as the degree of illumination, and the units to be used are selected as much for their effect upon the appearance of the street as for their efficiency and light distribution.

In the lighting of streets, pedestrian and vehicular traffic must be considered. The ideal condition for pedestrian travel is illumination that is not necessarily intense but which is uniform. This condition of uniformity is not so important for vehicular traffic, as will be pointed out later. Uniformity of illumination demands lighting units located at short intervals, a requirement that is met naturally by an ornamental system.

Four Classes of Streets

Streets can be divided into four distinct classes: (1) residence streets, the traffic on which is due mainly to the residents on the street itself; (2) residence streets handling considerable through traffic; (3) semi-business streets, those on which retail stores and residences are intermingled or streets given over to wholesale and storage houses or factories; and (4) main retail streets. On the streets of all but the first class other factors than those mentioned will enter. For instance, it is a recognized fact that high intensity of illumination has a decidedly stimulating effect and for this reason the main retail districts should have an illumination greatly in excess of the actual needs for safe travel.

Intensity of Illumination

Intensity of illumination is spoken of in terms of foot candles. A foot candle is the intensity of illumination on a surface 1 ft. from a source of one candle power or 2 ft. from a source of four candle power, etc. The following minimum intensities of illumination represent present practice fairly well: Purely residential streets, 0.02 foot candle (this is about equal to bright moonlight); boulevards or through streets and semi-business streets, 0.04 to 0.05 foot candles; main retail streets, 0.1 or more foot candles. To determine the size and spacing to produce the above degrees of illumination, it is necessary to know the distribution of

of light given by the lamp. The shape of the distribution curve can be controlled by the shape of the surrounding globe or by reflectors or by both together.

Comparison of Three Tops

A comparison will be made of three styles of tops, a ball globe, a top shaped to produce more downward light and a top using a prismatic refractor. A minimum illumination of 0.02 foot candles can be obtained with the lamps of 100 c.p. alternating on the two sides of the street and with spacings as follows, measured along the street: Ball globe, 90 ft.; shaped globe, 100 ft.; shaped globe and refracting dome, 117 ft. The comparative cost per 100 ft. of street for the standards and foundations is $672, $655 and $605, respectively. The saving in first cost shown by the second and third types is in a measure offset by the greater cost of glassware for replacing broken tops and this factor may, in some cases, lead to the selection of the first type. Where higher intensity is desired it can be obtained by using larger lamps or by placing the standards opposite each other or by both together.

Power can be supplied to the lamps either by means of a constant-voltage or a constant-current system. In the constant-voltage system (often called the multiple system) two wires are carried along the streets and 110 or 220 volt lamps are connected between them. The current to be supplied is the sum of the currents taken by the individual lamps and while the current taken by each lamp is small, the total may be quite large. The filaments in the lamps are long and of small diameter. This system is not satisfactory because the large current necessitates the use of large wire and also because the lamps do not withstand the vibration due to traffic well.

In the constant-current or series system the lamps are all connected in series, the same current flowing through all the lamps. This current can be made larger than that taken by a single multiple lamp but at the same time being much smaller than the total current in that system. If the current through a lamp is increased the voltage across it is decreased to keep the candle power the same. The total voltage of this system is the sum of the voltages of the individual lamps and may be built up to several thousand volts. The filament of the series lamp is shorter and larger than that of the multiple lamp and therefore it withstands vibrations better. For these reasons the series system is widely used and it is the system that will be discussed here.

Three Types of Series Systems

There are three types of series systems for supplying power to the lamps—straight series, straight series with current transformers at each standard, and the group system. In the straight series system, all of the lamps supplied by one regulator are connected in series across the regulator. If the district to be lighted is some distance from the control station, it is desirable to have as many lights as possible on one regulator to reduce the cost of cable from the station to the district. This results in the use of high voltage, which is undesirable for two reasons—(1) liability of injury to persons coming in contact with any part of the system; and (2) the high cost of cable suitable for such high voltage. On the other hand, this system has the advantage of simplicity, the equipment being reduced to a minimum.

In the series system with individual current transformers, an individual current transformer is installed in the base of each standard, thus insulating the lamp and leads up to the standard, from the high voltage carried on the underground cables. This system has the following advantages: (1) the life hazard present in the straight series system is eliminated; (2) if high power lamps are used the current transformers can be used to supply the large current required by the lamps while a smaller current is used in the line, thus reducing the cost of line copper required. When use is to be made of the small sized lamps, this advantage disappears. The disadvantages of this system are: (1) high initial cost; (2) increased number of sources of trouble due to the increase in the amount of equipment needed.

In the group system the lamps are divided into groups and one insulating transformer is used for each group. The advantages are: (1) the voltage of each group can be kept low enough to practically eliminate the life hazard present in the straight series system, nearly equalling in this respect the individual transformer system; (2) since the voltage for the entire group is lowered, a cheaper cable can be used than is required for either of the other systems. The disadvantages are: (1) the necessity of constructing manholes in which to place the group transformers; (2) a larger number of sources of trouble than with the series system. The following table gives

a comparison of the system with regard to possible voltage to ground from the lamp socket and the cost per standard. The figures given apply to 100 c.p. lamps installed in locations where it is possible to use parkway cable and assuming that 35 KVA regulators will be used to supply constant current to the entire circuit and that in addition 10 KVA series transformers will be used to supply the groups in the group system.

	Maximum Voltage	Cost per Standard
Straight series	5300	110.28
Individual transformer	11	135.28
Group	757	99.78

Mechanical Features

Cable for street lights can be installed in either of two ways. If conduit is laid in the ground, lead covered cable can be pulled into the conduit and connected to the various pieces of equipment. If no conduit is installed, lead-covered cable with two layers, each of steel tape and tarred jute around it, can be laid directly in the earth with no other protection, and connected to the various pieces of equipment. The main advantages of the conduit system lie in the fact that the cable can be replaced at any time without any excavation, while the advantage of the steel taped cable system lies in the lower first cost.

The type of lighting equipment to meet the needs of the different districts can be summarized as follows: (1) the residential section—100 c.p. lamps on 10½-ft. standards, alternate standards on opposite sides of the street, and steel taped cable; (2) the semi-residential section—250 c.p. lamps on 12½-ft. standards, spaced as above, and steel taped cable; (3) the semi-business section—250 c.p. lamps on 12½-ft. standards, spaced as above, and lead covered cable in conduit; (4) the business section—250 c.p. lamps on 12½-ft. standards placed opposite one another and lead covered cable in conduit. Alternate lamps on separate circuit to be turned out at midnight. Fairly typical costs per block of 400 ft. for the above layouts, using the group system, with an inexpensive standard and a ball globe are given below. These figures were worked out for a particular locality and are comparative only, local conditions affecting them. Court costs, supervision, inspection and cost of assessment roll for local improvements have not been included.

RESIDENTIAL LIGHTING

5 10½-ft. standards complete at $53	$ 265.00
5 20x20x24-in. foundations at $7.50	37.50
920 ft. 1000-volt steel-taped cable at $240 per 1000 ft.	220.80
50 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	9.00
0.40 KW station equipment at $43.40 per KW	17.32
0.40 KW distribution equipment (mains, manholes and transformers) at $246.40 per KW	98.56
Total	$ 648.18

SEMI-RESIDENTIAL LIGHTING

5 12½-ft. standards complete at $65	$325.00
5 24x24x30-in. foundations at $8.50	42.50
920 ft. 1000-volt steel-taped cable at $240 per 1000 ft.	220.80
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 100 ft.	10.80
0.825 KW station equipment at $43.40	35.72
0.825 KW distributing equipment at $264 per KW	218.13
Total	$ 852.95

SEMI-BUSINESS LIGHTING

5 12½-ft. standards at $65	$ 325.00
5 24x24x30-in. foundations at $8.50	42.50
5 18x18x24-in. pullboxes at $22	110.00
920 ft. 1000-volt lead-covered cable at $100 per 1000 ft.	92.00
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	10.80
920 ft. 1-duct conduit in place at $1.60 per lin. ft.	1,472.00
0.825 KW station equipment at $43.30 per KW	35.72
0.825 KW distributing equipment at $264.40 per KW	218.13
Total	$2,306.15

BUSINESS LIGHTING

10 12½-ft. standards complete at $65	$ 650.00
10 24x24x30-in. foundations at $8.50	85.00
10 18x18x24-in. pullboxes at $22	220.00
1840 ft. 1000-volt lead-covered cable at $100 per 1000 ft.	184.00
120 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	21.60
920 ft. 2-duct conduit in place at $1.70 per lin. ft.	1,564.00
1.65 KW station equipment at $43.40 per KW	71.44
1.65 KW distributing equipment at $264.40 per KW	432.26
Total	$3,232.30

These totals give the following unit costs:

	Cost per Run. ft. street	Cost per ft. of Property	Cost per Stand.
Residential lighting	$1.41	$.81	$129.60
Semi-residential lighting	1.86	1.07	170.60
Semi-business lighting	5.01	2.88	230.62
Business lighting	7.04	4.04	323.23

Illumination of Highways

It is becoming desirable to furnish some illumination on the main highways in order to render the use of bright, glaring headlights unnecessary, thereby avoiding a number of accidents which are caused by glare blindness. The problem of highway illumination is greatly different from that of city streets. Since the traffic is almost entirely vehicular, uniformity of illumination is not of so great

an importance. The main object is to make it possible to perceive objects or bad spots ahead of the car. Three factors contribute to this perception: (1) direct illumination of the object by the light source; (2) silhouetting of the object against the bright area under the lighting unit; and (3) reflection from the surface of the roadway. Probably the least important is the direct illumination, and for this reason large units spaced fairly far apart can be used.

The lamps should be of the constant-current series type, for which a regulator is necessary. On the basis of 400 c.p. spaced approximately 400 ft. apart, one 35 K.W. regulator will light about 10 miles of roadway. The cost per mile for such an installation would be approximately $1,700 if a pole line is available, and it would only be necessary to support and string the wire and mount the lighting units; and approximately $2,500 if it is necessary to set poles.

The foregoing is a paper by Professor Knight before the 1923 convention of the Illinois Society of Engineers.

THE TRUTH ABOUT CANTONMENT CONSTRUCTION COSTS

By Dabney H. Maury, Consulting Engineer, 1445 Monadnock Block, Chicago, Ill.

(Editor's Note: The story of the cantonments has been written many times in this and other publications, but never, so far as we know, as well as in the following article. The economics of cantonment construction is still a live subject because of the charges brought against prominent men in the construction industry who were engaged on the work. The facts and figures here presented will be of greatest interest to engineers and contractors for reference purposes. The general public long ago accepted the false version as the true one and while the false may be forgotten the true will scarcely be embraced at this late date.)

The office organization charged by law with the construction and maintenance of barracks and quarters consisted in April, 1917, of some thirty persons: A Colonel, two Captains, an Engineer, an Architect and sundry Clerks and Office Assistants. It was at this crisis that there was appointed the Advisory Committee to the Committee on Emergency Construction of the Council of National Defense, to whose intelligence, patriotism, vision and genius were due the organization of the Construction Division, and to a very large extent the marvelous results accomplished by that Division.

Morton C. Tuttle of the Aberthaw Construction Company of Boston; Leonard Metcalf, of Boston; George W. Fuller, of New York; William A. Starrett, of New York; Frederick Law Olmstead, of New York and Washington, and Asa E. Phillips of Washington, were the men who, during May, 1917, laid the foundation for the organization of the Construction Division, selected its original personnel, and prepared the remarkable Cost-Plus-A-Limited-Fee Contract, which made possible the construction of the camps within the time limit specified.

One of the first things done by this Advisory Committee was to canvass the United States for the engineers who they thought would be needed. The members of the Committe knew personally or by reputation practically all of the prominent engineers in this country, and from these a list of 300 was selected. Each of these men received a telegram reading about as follows: "Will you give some of your time to work for the U. S. Government? o appropriation for services or expenses though one may be had later. Answer."

I saw the list and the answers. There were 299 "Yes's" and 1 "No." Those 299 men so selected formed the nucleus of the Construction Division.

To many of those same men this telegram was later sent: "Wire immediately names of Contractors in your vicinity who have the equipment and organization sufficient to enable them to complete from three to five million dollars worth of work in three months and whom you personally know to be fit to be entrusted with such work on a cost plus fixed sum basis."

The best contractors in the United States—and that means the best contractors in the world—were thus mobilized and staked out in advance for the Construction Division. When the time came those contractors thus selected each received a telegram to come to Washington—and in every case the response was immediate. Those men came down, brought their organizations, sent for their equipment, and went out to their jobs; and they worked there, in many instances, for three weeks, before they even saw the contract which they were expected to sign.

Under no other form of contract than that prepared by the Committe could this

work have been done on time, and under no other form of contract could it have been done at that time as cheaply as it was done. No sane contractor would have bid on a lump sum contract, even had plans and specifications been ready—which they were not.

The impression has gone abroad throughout the land that this contract was a cost-plus-a-percentage agreement, and that the more money a contractor spent or wasted, the larger would be his fee. This impression is absolutely false.

The contractor's fee for each of those great camps was limited to $250,000. The average fee earned by all of the contractors for the army camps was about 2½ per cent.

The camps themselves were far superior in every respect to any war camps which any nation has ever constructed. The buildings were better, their equipment was better, the commissary was better, the water supply and sewerage and general sanitation were better—the fire protection system, the electric light, the heating, the laundries, the hospital service—were all superior to any ever enjoyed by troops in training during war time anywhere in the world.

The 16 army camps were built to house about 640,000. Their total cost was $198,000,000. This represents $300 per man, and for this sum there were given comfortable quarters, plumbing, heat, light, water supply (hot and cold), sewerage and sewage disposal, garbage disposal, fire protection, roads, pavements, railroad facilities, warehouses, laundry, and a large and splendidly equipped hospital. Let any man take his pencil and figure the cost of similar accommodations and facilities to the average citizen today and then say whether or not these camps were costly.

The water supplies for the 16 National Army cantonments cost $11 per capita. Any man familiar with the cost of water works will tell you that the water works of the average city of 40,000 people in this country could not possibly have been reproduced new in 1917, for less than $55 per capita.

The purity of the water furnished by the systems installed or enlarged by the Construction Division is best attested by the fact that these water works systems handled during a period of two years, in about 350 places in the U. S. and its Island Possessions, more than 4,000,000 troops and more than 2,000,000 civilians, without one single case of typhoid or other water-borne disease being charged to the impurity of any supply.

The adequacy of the supplies is shown by the fire record. The camps were of the most inflammable construction, and thousands of fires were started; but in only three instances was any fire allowed to escape beyond the building of origin, and in each of these three cases one-half of the barracks building in which the fire originated was saved, and one-half of the mess kitchen to which it spread.

The per capita fire loss for the year 1918, throughout the U. S., was $2.67. The per capita fire loss in the army camps and other Construction Division activities was 67c for the same period. More than half of this 67c was the loss in hay piles, which were located in the corrals, beyond the reach of the water mains in the camp, and for which no attempt was made to provide fire protection.

It seems hardly necessary to say that the credit for these results belongs to no one man, but is shared by every one of the thousands of men, not only in Washington, but in the field, whose duties brought them in touch with the design or construction of the work.

But above all and beyond all other considerations was this great fact. Each day by which the arrival of American reinforcements in France was delayed meant from 5,000 to 10,000 allied soldiers killed, from 50,000 to 100,000 more wounded, and several hundred million dollars of war expenditures, and endangered to a frightful extent the fate of the world—for without the speedy arrival of American troops the war would have been lost.

Thanks to the organization of the Construction Division, planned by the splendid men on the Committe just referred to, these 16 camps, and 16 other camps accommodating another 640,000 men of the National Guard troops, were all ready to take troops, as ordered, by Sept. 1, 1917—some of them within less than two months after they were begun.

This record of accomplishment was not approached by that of any other organization in the army. If the camps had cost four times as much, they would have been cheap under the circumstances. Nevertheless, certain men, apparently for political purposes, are now compelling the contractors who built those camps to defend suits, which, even if they are never tried, will greatly impair the reputation and business credit of every one of these able and patriotic Americans and will cost each of them many thousands of dollars

for the legal expense required to prepare to defend the suits. But worse than that, indictments charging criminal conspiracy, treason and other heinous crimes, have been brought against six of the most prominent, efficient and patriotic of all of the individuals to whom credit for the accomplishments of the Construction Division is due.

Many months have elapsed since the cunningly worded charges against the contractors and the indicted individuals were given the widest possible publicity through the daily papers of the country, and yet, five years after the war, the Attorney General is asking for more time for preparation of the cases, and has, up to date, failed to furnish any one of the bills of particulars ordered by the Courts.

Meantime, all of the men sued or indicted, stand pilloried before their countrymen, without having been given any opportunity to clear their names.

No one having competent knowledge of the facts, can consider these suits and these hideous indictments, brought in the name of our Government, by men who can not be sued for their official acts, and the subsequent delay in giving the accused persons an opportunity to defend themselves, as less than outrageous.

The foregoing matter is from a paper by Mr. Maury before the recent annual meeting of the American Water Works Association.

STREET LIGHTING FOR THE SMALL CITY

By G. B. McNair, District Illuminating Engineer, Westinghouse Electric Mfg. Co.

Most of us can remember when we used the carbon lamp for lighting our houses. But who would be content with the carbon lamp now? In the same way we are becoming more and more accustomed to high illumination values on the street and we require more light to see quickly. The rapidly moving automobile makes it necessary that we see quickly or accidents results.

Retail merchants are alive to the necessity of bright, attractive show windows because people stop before such windows. In the same way, it has been found that trade follows the bright lights of streets. People prefer to go along well lighted streets and business locations on such streets are more desirable and bring higher rents.

Accidents form a very potent reason for adequate street lighting. A very careful investigation by Mr. Ward Harrison, of the National Lamp Works, showed that 17 per cent of all the street accidents are directly due to insufficient illumination. In this investigation, proper allowance was made for every other contributing cause, and still one accident out of every six could be charged directly to insufficient light.

Crime has always gone hand in hand with darkness. The worst deeds are usually committed under cover of darkness. This is so commonly known that "daylight robberies" are given a great deal more space in newspapers than the same crimes committed under cover of darkness.

It was found that in Cleveland, Ohio, crime actually decreased 8 per cent. in the brightly lighted area while elsewhere there was an increase of 54 per cent.

In Chicago an attempt was made to save money during the coal shortage, by turning off the street lights. Immediately the number of hold-ups increased so alarmingly that it was absolutely necessary to turn the lights on to save the people.

In smaller cities there is often a very vague idea of what is necessary to provide adequate light for different parts of the city. The citizens often have the idea that the cost is so high as to be not worth considering. Actually, such lighting pays for itself in a short time in increased business and the cost is quite moderate.

Suppose that one hundred people walk along a certain block in a certain time. About four of these are down town to buy definite things. If the merchants on a street, by means of good street lights, bring to their doors half of the other ninety-six, they have done more than most other forms of advertising will do, and who does not believe in advertising, these days?

Having agreed that better lighting is necessary, the next question is "How shall it be paid for?"

If at all possible it should be put in as a municipal improvement and paid for by the city, because the city as a whole benefits, but if this can not be done because of lacks of funds, the next best way is to create an improvement district and assess the cost against the property frontage. This is done by initiating a petition and securing signatures for 51

per cent of the property frontage. This is presented to the Council, who will then pass an ordinance creating the district and directing the City Engineer to prepare specifications and take bids or otherwise provide for one purchase according to law.

Sometimes the Central Station has attempted to make individual contracts with the property owners. This almost always turns out badly as some property will be sold and the new owner will not continue the contract.

If the street is to be paved a strenuous effort should be made to get the city to buy cable and put it in ahead of the paving. This will save the heavy expense of trenching in the concrete at some later date and thus remove one great obstacle in the way of purchasing ornamental standards, namely, the cost of this trenching.

Every city that has put in ornamental lighting has found that the advantages so far out-weigh the value of the money expended that it could not be persuaded to go back to the old dark streets.

The commercial advantages are felt within a year, and the comfort in walking and driving, the first night the lights are turned on.

Just as the carbon lamp has been superseded by the gas-filled Mazda lamp, so the "bug lights," high up on poles about a block apart, will be finally replaced by ornamental posts close enough together to give real illumination adequate for all purposes.

FEATURES OF PLAIN MACADAM ROAD CONSTRUCTION

By William G. Tonkel, Road Superintendent, Allen County, Ft. Wayne, Ind.

I find that with very few exceptions the specifications on macadam roads today are the same as they were 10 years ago and I think this should be remedied at once, for 10 years ago we knew very little of the 5-ton truck carrying about 10 tons of weight. The specifications consisted of about 6 or 8 ins. of base material rolled down, on top of which 2 or 3 ins. of screenings was thrown, as a filler, and the result today is that when heavy loads pass over this kind of a road they tear through, the road gives way, and holes and chucks appear in a very short time, which of course necessitates quite a lot of maintenance.

In the construction of a good, plain macadam road I would suggest the following specifications: First of all 100 per cent drainage. Next a 12 in. base of large stone, consisting of about 8 ins. of stone ranging from 4½ to 2½ ins. in size, on top of which a thin coating of screenings should be placed and then rolled down.

On top of this a second course of stone ranging from 2½ to 1½ ins. in size, 4 ins. thick, on top of which a 3 in. layer of coarse screenings grading ¾ in. to dust should be spread and rolled down so that the voids in the coarse stone would be entirely filled.

A very important factor in a successful plain macadam road is the rolling. By attaching a sprinkler arrangement along with the roller and rolling a road, not once, but 25 times from end to end, you are bound to create a solid mass of metal.

A fault I find with the present day method on the plain macadam construction is the fact that the contractor wants to put down a base of so many inches of coarse stone and then put on about 5 or 6 ins. of screenings, thus making the required depth as per specifications. This, I think, is a very serious fault, for screenings are not supposed to be a wearing surface but are supposed to be a filler for the voids so that each large stone will be keyed in place and in time cement itself together into a solid piece of metal.

No doubt the contractor would much rather put on a thick coating of screenings because it handles much easier, rolls much easier, and immediately upon completion of his job he calls the county commissioners, the surveyor and superintendent on the road and shows them a very smooth job, but this only holds for a little time and soon the screening coat starts to pit up in small holes and buckle in waves, but after his job is accepted he does not seem to care. Why not put on a coarse screening of about 3 ins. in thickness and roll this down so that a smooth surface will result and at the same time your wearing material (that being the coarse aggregate) will be close to the surface?

Another thing that should be done is to put on an inch or inch and a half coating of limestone chips grading from ¾ to ¼ in. free from dust on top of all this. This would serve as a guarantee to the wearing surface.

After a macadam road of this type has been constructed and has served the community for a number of years, and in the course of progress this road graduates from the feeder type to a main artery of

commerce I can see no reason why this solid road bed should be torn up and thrown away for I think that what is known as an umbrella-type of construction (by this I mean a top of some bituminous material on top of this solid base) would change this plain macadam road into a pavement type of construction which is resilient and adapts itself to climatic conditions.

I know this to be very successful, for in Allen County we had this very experience. The Maysville Road, leading out of Fort Wayne in a northeasterly direction, is at present the main artery of travel for all Detroit and Toledo traffic. A portion of this road was constructed in 1914 at a cost of about $9,000 per mile. Aside from a miscellaneous maintenance expense it cost practically nothing to repair until in 1922. We decided to resurface this road according to the bituminous penetration method, the cost of which did not exceed $6,000 per mile, and today we have one of the smoothest pavements on this road that can be found in Allen County. Therefore, the original construction cost as well as the maintenance cost since 1914 has been about $15,000 per mile and a feeling of satisfaction and contentment exists in this community with all who have occasion to use this highway.

Therefore I feel that as every feeder highway graduates into a main artery of transportation that instead of tearing up the old road-bed and throwing away the initial cost of construction that with a few added dollars spent along this line you can give the community a paved road second to none.

Of course it is necessary to maintain and keep up this type of construction, but I know of no highway that is permanent and free from maintenance except it be the ocean, the great lakes and our navigable streams.

The foregoing matter is from an address presented at the recent Road School at Purdue University.

A STUDY OF TRAFFIC ACCIDENTS ON IOWA HIGHWAYS

(Editor's Note: The following facts and figures on traffic accidents on Iowa highways are reproduced from the Service Bulletin of the Iowa State Highway Commission.)

Deaths on the Iowa highways in accidents of various kinds during 1922 total 330. Sixty-six of these 330 deaths occurred in railroad crossing accidents. The balance of 264 occurred in accidents on the other portions of the highways.

There was a total of 6,513 accidents recorded in the clippings from Iowa newspapers which came into the Highway Commission office during the year. In these 6,513 accidents recorded there were, in addition to the fatal accidents, 7,281 persons whose injuries might be classed as serious, with either broken bones or badly cut and bruised.

In the past seven years in which these accidents have been recorded, from the same sources, there has been a total of 1,878 deaths. Of this number, 442 occurred on railroad crossings with 1,436 on other portions of the highways. There have further been recorded 27,754 accidents of all kinds with a total of 28,000 seriously hurt.

While the reports from which these accident tabulations are made are not official in any respect, it is believed that they are correct in regard to the number of fatalities. There is perhaps no accident in which the injured persons die within a few weeks' time of the accident, which is not recorded in some one of the daily or weekly papers of the State. It might happen that in case a person injured should linger for months before the death occurred that the cause of the death would not be ascribed to the accident in which the injuries were received. From a somewhat comprehensive study of the accuracy of these accidents over a period of several years, it is believed that absolute reliance may be placed upon the portions of the summary covering fatalities. So far as accuracy is concerned in the report of other accidents it is likely that the figures are entirely too small. There are many serious accidents which are never reported in any of the Iowa newspapers. Further, from the careful manner in which the Iowa papers are scrutinized daily by trained experts in the clipping bureau which supplies these clippings, it is not believed that any appreciable percentage of accidents of any kind escape the attention of the clippers.

It is interesting to note in the monthly tabulation for the year 1922, which accompanies this article, the relative proportion of the accidents in the various months. Reference to the monthly tabulations for several years back indicate that the same relative proportions are carried out from year to year. April has almost invariably been the lightest month for accidents. In 1922 there were 10 fatalities

in this month. February and March usually have a few more. In 1922 there were 15 in each month. From April the increase is steady through May, June and July. August, September and October are invariably the heavy months. In 1922 there were 42 fatalities in August, 47 in September and the same in October. From this time on the drop is steady until the low point period is reached in April with this record of 10 in 1922.

Noting the tabulation of deaths on railroad crossings, September and October were the high months in 1922, the total number of deaths being 18 and 22 respectively. There were three months—March, April and June—in which no crossing accidents causing deaths were recorded. In 1922 there were 30 fatalities less on the railroad crossings than in 1921. It is possible that this reduction of the number of accidents may have been due in part to the extensive campaign which has been carried on during the past year against careless and reckless driving on the highways and the special campaigns for the reduction of grade crossing accidents through the exercise of greater care on the part of automobile drivers.

Head-on collisions on the open highway are the most prolific source of road accidents. In 1922 there were 1,693 accidents recorded in the daily papers; 1,236 persons were badly cut and bruised and 337 people recorded with broken bones.

The next most prolific source of accidents was in the tabulation of people struck by automobiles. Of these, there were 1,105 accidents, in which it was recorded that 1,044 of the persons struck were seriously hurt.

The third most prolific source of accidents is contained under the classification of automobiles over embankments. Under this classification is listed any type of accident in which the car leaves the highway and goes over into the side ditch. This does not necessarily imply that the accident occurred on the highway where there is a high grade or a deep ditch. There were 653 accidents of this type with 664 people badly cut and bruised and 210 with broken bones.

Accidents in which automobiles turned turtle, which is the common term for cars upsetting, either turning completely or partially over, total 588 with 962 people badly hurt and 249 with broken bones. It is interesting to note that this type of accident results in more injuries on the average per accident than under several of the other classifications.

Two hundred forty-five automobiles were struck by trains in railroad crossing accidents with 284 people injured.

In the other type of accident in which the train is struck by the automobile, there were 32 recorded with 38 people hurt.

One hundred eighty-eight buggies were struck by automobile with 264 people injured.

Car skidding is scheduled as responsible for 257 accidents and accidents due to the breaking of some part of the car comprise a total of 299. Glaring headlights on automobile were given as responsible for 92 accidents and 65 accidents were due to intoxicated drivers; 64 automobiles plunged over or through bridge railings into the stream bed below.

Careless and reckless driving would seem to be the cause of perhaps 90 per cent of all the accidents on the highways. It is very seldom indeed that the design, construction or maintenance of the highway is responsible for accidents. As the summary indicates, a very small percentage of accidents are due to car breakage or weather conditions. Car skidding, for instance, would seem to be a prolific case, was responsible for only 257 acci-

ACCIDENTS AND FATALITIES ON THE IOWA HIGHWAYS DURING YEAR 1922

Month	Total Deaths	On Highways	On R.R. Crossings	Total Accidents	Total Hurt
January	23	17	6	313	309
February	15	13	2	269	293
March	15	15	0	223	237
April	10	10	0	252	279
May	19	18	1	389	475
June	25	25	0	547	496
July	34	25	9	518	455
August	42	37	5	868	978
September	47	29	18	820	1,009
October	47	30	17	1,006	1,268
November	28	23	5	628	708
December	25	22	3	680	774
Total	330	264	66	6,513	7,281

ACCIDENTS AND FATALITIES ON IOWA HIGHWAYS FOR PAST SEVEN YEARS

Year	Total Deaths	On Highways	On R.R. Crossings	Total Accidents	Total Hurt
1916	199	146	53	2,574	2,834
1917	281	219	62	5,100	5,208
1918	237	175	62	3,027	3,450
1919	203	153	50	2,809	2,708
1920	269	216	53	3,048	3,124
1921	359	263	96	4,683	4,195
1922	330	264	66	6,513	7,281
Total 7 yrs.	1,878	1,436	442	27,754	28,800

ACCIDENTS IN WHICH NO FATALITIES OCCURRED IN 1922 ON IOWA HIGHWAYS

		Persons Injured
653	Autos over embankment—	
	Persons with broken bones	210
	Persons cut and bruised	664
588	Autos turned turtle—	
	Persons with broken bones	249
	Persons cut and bruised	962
1,693	Autos in collision—	
	Persons with broken bones	337
	Persons cut and bruised	1,236
188	Autos collide with buggies	264
60	Autos collide with motorcycles	68
148	Autos collide with street cars	144
88	Autos collide with bicycles	80
281	Autos into obstruction in road	320
1,105	People struck by autos	1,044
245	Autos struck by trains	284
32	Trains struck by autos	38
252	Accidents with horse vehicles	268
43	Autos causing runaways	49
299	Accidents due to car breakage	436
257	Accidents due to car skidding	282
92	Accidents due to glaring headlights	160
65	Accidents due to driver being intoxicated	89
334	Accidents where autos were damaged and no one hurt	0
64	Autos plunge into creek over bridge	71
26	Coaster accidents	26
	Total accidents	6,513
	Total number of people injured	7,281

dents, while autos in collision in which the fault it would seem, in 99 out of 100 cases, would be with the drivers, totaled 1,693.

As stated many times in the Service Bulletin, safety on the Iowa highways as they are now designed, constructed and maintained is a matter of safe driving or of having reasonably careful drivers in charge of the cars on the highways. Put the unsafe driver off the highway and a very large percentage of the accidents occurring on the highways would be eliminated at once.

That the fault is almost entirely due to the driver and not to the highway or the car is amply evidenced by the fact that the large percentage of serious accidents as reported, not only in Iowa but in other states as well, take place not at what might be considered danger points on the highways but on the best improved straight-away stretches, and on perfectly smooth hard surfaced roads. The inference is that speeding beyond rational limits, the condition of the road surface and the traffic present on the road considered, is perhaps the one greatest single cause of highway accidents.

NOTES ON CITY PLANNING AND ZONING

(Editor's Note: The following concise summary of the advantages of city planning and zoning, in cities of all sizes, is from a report of a committee of the League of Minnesota Municipalities as presented at the recent convention at Faribault. The committee was composed of N. N. Bergheim of Little Falls, D. J. Chatham, Faribault and George H. Herold (chairman) of St. Paul. It is expected that a law making possible city planning and zoning in Minnesota will be passed at the next session of the legislature of that State).

It is only within the last few years that city planning has been recognized as a legitimate municipal function. This tardy recognition is due largely to the fact that early planning dealt almost altogether with specialized features, civic centers, group plans and other costly projects; the first published reports were overburdened with projects impossible of accomplishment, and magazine writers overplayed the "City Beautiful" idea until the whole subject fell into disrepute. In the meantime less spectacular workers were obtaining evidence which proved that the ills of a town were due more to its deformed and unguided growth than to forms of government, personnel of councils and charters or ordinances.

A study of the layout of any town brings out the fact that the original town site plat prepared by the proprietor of the land becomes the framework or plan of the future town. The streets were laid down on this plat for the purpose of bounding lots and if corner lots were in demand cross streets were put in to create them. Little or no thought was given to the streets as a means of transportation. The law requires that platted property must have means of access and the proprietor complies with the law and no more, so that the street system of any town or city is simply what the proprietor of the original town site saw fit to give for public use, and here, therefore, is the starting point, where may be found the germs that in future years brings to so many towns of promise the "sleeping sickness," "paralysis" and "deformity," and a costly surgical operation is the only cure.

Town planning is simply sound economics; every town must have its utilities, sanitary requirements, convenience and service and the cost of these are the

cost of town living. Streets graded, paved and guttered; sewers; water mains; fire protection; gas mains; telephone lines; electric distribution lines; steam heat; power lines; transportation; lighting service; parks; boulevards and playgrounds are all component parts of the town and are designed for certain conditions. If these conditions are guessed at, then the public's money is wasted through constructing larger or stronger and more extensive units than are needed or through constructing smaller units than will be required and then rebuilding them. Every public utility, private or municipal, that can forecast its probable demand of service accurately can furnish that service at the least cost. A zoning ordinance makes an accurate forecast possible.

Furthermore, when commerce brings together an aggregation of people to form a town they, in order to live together harmoniously, elect a set of officers to umpire the game. There is no state constitution that gives to any City Council any power other than that of an umpire.

The officials of every town should do what is possible to insure the purchase of a home as a good investment, for the purchase of a home is the one big investment of a large majority and it should be protected against every kind of value destroying encroachment. You cannot go to a town of any size but what you will find blighted districts where homes have been turned into boarding houses, tea rooms or are vacant, the original value of the district having been destroyed by the building of a store, laundry and the like, in close proximity, thus causing a migration of the home district. There being no compensating use for these homes the original owners lose their value and the town loses in taxes. Residence districts should not be permitted to deteriorate in this way; old homes are more valuable than new ones if kept in repair, and renewal and repairs would be made for years if the district was protected against non-conforming uses. Homes should be worth more after twenty years than the day they were built, and when a man buys a home he should feel assured that he can leave this home to his children with all its value intact, or increased in value by the labor, thought and development that he put in it through the years.

The city or town plan well executed is a big problem requiring the best effort of the most forward-looking citizens for one part of the plan exercises an influence over other parts. Land should not be set aside for parks that foresight and possible knowledge shows, should in time become residential or business property. The most delightful parks are those which have been created out of swamp, low-lying or broken land unsuitable because of topography for any other use. Arterial highways should be laid down in the town plan and all their features worked out in detail so that platting and connecting cross streets may work in with it. When a railroad company builds its grade the line is laid down to fit the topography so that material taken out of cuts will exactly fill the low places and bring the roadbed to grade. A municipality grades its streets piece-meal; if there is an excess of dirt the contractor wastes it or sells it and then when the part of the street is graded, that requires a fill, the earth must be bought and hauled from a long distance. This is just one of the costs of living in a town that is unnecessarily great because of the lack of planning. Arterial streets should not have too many intersecting streets. Every cross street presents a problem in safety. Blocks along an artery should be at least one-quarter of a mile long; foot paths 10 or 12 ft. wide may be provided intermediately.

The committee desires to call attention to the possibility of an entirely different development plan for small towns than the present system. It would be based on traffic necessities and community needs. A Town Planning Board regulating platting and a zoning ordinance regulating the use of property are needs of every community within the State.

A City Plan would improve traffic conditions, lower the cost of transportation and distribution of commodities, increase business, safeguard residential areas, rehabilitate blighted districts, stabilize property values, create high-class retail districts, place factories and warehouses in desirable locations where they may thrive without protest from residential owners, create ample recreational areas and do this in a scientific manner.

PENNSYLVANIA NOW HAS MOTOR VEHICLE CERTIFICATE OF TITLE LAW

After Nov. 24, 1923, it will be illegal in Pennsylvania to own or operate a

motor car without a certificate of title, the Department of Highways recently announced. It will not be possible to secure 1924 license tags until a certificate of title for the automobile has been recorded with the Department of Highways.

The title law, signed by Governor Pinchot May 24, 1923, provides that every motor vehicle, whether passenger or commercial, every motorcycle and motor bicycle in Pennsylvania must be titled prior to Nov. 25, 1923. In other words, owners of such vehicles must possess a legal title, somewhat similar to the title for real estate.

Within a short while the Department of Highways will mail specific notice to all owners, together with an application for a certificate of title. These owners will also receive a copy of the title law and information telling them the exact location of the engine and manufacturer's numbers on their cars. Special stress will be placed on these numbers. If the numbers shown on the application for certificate of title are inconsistent with the year shown on the application—or should the number of any particular part of the motor or vehicle be listed instead of the engine or manufacturer's number, the application will be returned for correction. Under the title law the engine number file will be the predominating file. The duplications of engine or manufacturer's numbers will be carefully checked and titles will be cancelled when carelessness is shown in setting forth these numbers.

Although the new law will not prevent the stealing of motor vehicles, it will, Secretary Paul D. Wright declares, prevent the sale of stolen motor vehicles in Pennsylvania. Other states have found it an admirable check on stolen cars. No car may be transferred in any way unless there is a clear title for it.

An illustration of the operation of the title law is as follows: A manufacturer delivers a new car to a dealer. The dealer immediately makes application for a certificate of title on a blank especially prepared for his use (in case of new car) and receives from the Department certificate of title for this car at a fee of 50 cts. The dealer then sells the car to a purchaser and assigns title to the purchaser by endorsing the assignment on the reverse side of the certificate of title. The purchaser, to secure a certificate of title, merely answers a few questions on the assigned title, signs his name in the space provided and forwards it to the Department with a fee of $2, at which time the Department issues a new certificate of title to him and retains the assigned title. Pennsylvania has gone a step further than other states by allowing purchasers of cars to apply for certificate of title and license tags on the same blank under one notarial seal. Should the purchaser subsequently desire to sell or trade his car, he follows the procedure outlined above. One car receives but one title number and transfers from time to time are designated by letters A, B, C, D, etc., preceding the title number. This is another step in advance of the majority of states. Maryland issues a new certificate of title each time the same car changes hands. For example, should Ford car No. 500 change hands five times in one year it would probably receive the following title numbers in Maryland: 1, 2550, 55098, 101022 and 205000. To check title on this car, five records would be traced. In Pennsylvania, should Ford car No. 500 receive title No. 1, subsequent titles would be numbered A-1, B-1, C-1 and D-1, the record being kept intact in one file. This serves as an immediate check and eliminates endless research and filing work.

Certificate of title is good for the life of the car, so long as the car is owned by the original owner of such certificate or held by the original owner of such certificate of title, and need not be renewed annually. Application for certificate of title shows the kind of encumbrance or lien, the date, the amount and in whose favor it is drawn. When the certificate of title is issued, the amount of the encumbrance, as well as in whose favor it is drawn, are listed thereon. Any person purchasing or acquiring a motor vehicle with a lien or encumbrance thereon does so at his own risk. He should examine the title that is being assigned to him before accepting the motor vehicle. Encumbrances will be removed from the certificate of title when it is satisfactorily proven to the Department that they have been paid and all purchasers of motor vehicles are urged to examine the title and exercise the same caution as they do when they procure a piece of real estate property.

CIVIC CO-OPERATION AT STEVENS POINT, WISCONSIN

By Morgan Chase, Secretary-Manager, Chamber of Commerce, Stevens Point, Wis.

It is highly important that a complete understanding be effected early in the mixed associations of the officials of any city and its Chamber of Commerce. Understanding is the base upon which men must deal with each other. Without this confusion turns worthy efforts into failure and good men into first class enemies.

Understanding is not reached under the strain of Domination. One must gain it through the use of careful planning and much patience, and through proper knowledge of human nature.

I am not one who believes that politics makes honest men dishonest. Neither does business. Nor any other pursuit I can name. It is a mighty safe bet, then, that the average city official is just as honest and tries to do his duty just as hard as the average chamber of commerce member or official.

With such belief it is not the most difficult thing in the world for the City government and the Chamber of Commerce of Stevens Point to live in peace. Though we may sometimes disagree, we do not become disagreeable about it.

The Chamber of Commerce is a minority organization and for that important reason it cannot hope to accomplish a single worthy object unles it can do so by persuasion. And if it can accomplish much well may it be said that the objectives to which it has worked have been right and that its methods have been respected.

We in the Stevens Point Chamber of Commerce believe that wherever possible it is mighty good business to take the city officials into our confidence at the outset. After our idea is well incubated and nursed into healthy being we approach our friends, the Council members, and our Mayor and lay it "unofficially" on the table. And then we let them think of it and amend it and finally look upon it as their own. True, sometimes, it is not acceptable at all.

But after all is any man or group of men able to turn out and execute an undiminishing stream of one hundred per cent ideas? Do we turn on the official family and complain because a certain idea of ours upon which we had probably been working for a year or more was not brought into being? By all means we do not. And if the idea strikes the official family right and it comes before them in a formal manner and is passed and becomes an ordinance we record it as a joint effort which brought good results and set it down in this way on our yearly report: "Assisted the mayor and council in accomplishing the arterial highway system," or whatever the job might be.

It is pertinent that the secretary of a Chamber of Commerce remember that if he develops an antagonistic attitude toward the officials of his city in any of his spoken or printed words that they will develop a like attitude toward him, a purely human thing to do. They have it in their power to hamper greatly the work of the chamber secretary if they believe him to be merely a self advertiser, who can't play the game square.

The matter of credit for completed work bothers many chambers of commerce and their secretaries to the extent that they are apt to make inroads on that which accrues either in whole or in part to members of the city administration. And on the question of credit have many such organizations gone to their Waterloo.

There is enough credit to go around, and there are hundreds of things which are entirely and purely the work of community organizations for which ample credit will follow satisfactory execution. When that is realized another step will be taken toward real helpfulness. When we take a measure before our mayor and aldermen we know we must convince them of the merit of our case. We work on that principle only and do not ask support as a personal favor. Another thing—before we take up a piece of work we know through referendum to our membership that our stand meets with the majority mind.

Perhaps better working partnership could be brought into being between other city administrations and their chambers of commerce if both would realize just what the latter is created to do. In a few words it's one big reason for living "to make the public think in civic terms;" to focus thought; to provide a place where citizens at large, without respect to membership alone, may find common ground on which to propagate the seeds of civic pride and on which to create the center of unofficial civic activity.

The foregoing is from an address by Mr. Chase before the League of Wisconsin Municipalities.

Construction News and Equipment

TEN THOUSAND MILES OF NEW ROADS IN THE SOUTH

Over 10,000 miles of roads were completed or placed in an advanced stage of construction in sixteen southern states during 1922, at a cost in excess of $165,000,000.

Bonds for good road development during the year reached a total of $132,199,615, and since much of the expenditure for new roads comes from state taxable sources and from federal aid, it can readily be seen that $200,000,000 is more nearly correct.

One of the most important developments in recent southern road building is the large amount of hard surfaced roads being laid. Until two or three years ago, unbound macadam was the only hard road laid out, today, 20 to 50 per cent of all state highways being built are hard surface. The time is very near at hand when the northern and eastern tourist can make his Florida trip over perfect roads every mile of his journey.

Taken with the federal aid appropriations for the period 1921-1925 and the new bond issue, North Carolina, for instance, has available the enormous sum of $120,000,000 with which to develop the network of highways that traverse the state.

Under the stimulus of what its neighbor is doing, South Carolina is now projecting a bond issue of $50,000,000 for road development. Sentiment has been widely crystallized and the probabilities are that the bond issue will be passed within another 12 months.

Georgia, while turning down an ambitious program of bonds to total $75,000,000 at the last meeting of the legislature, is awakening to the necessity of statewide action, and something definite in the way of a large bond issue for state highways will probably result at an early date.

Arkansas, Oklahoma and Texas are building rapidly and with permanence. In Arkansas and Oklahoma, the counties which have recently been enriched by the sudden wealth of oil development are investing large sums in hard surfaced roads, in the construction of huge bridges and in opening up additional areas to motor traffic. The vital need of automobile communication in the oil areas has spurred on the sections around Fort Smith, El Dorado, Muskogee, Tulsa and other points to ever-increasing development.

Texas, with its hundreds of miles of distances, during the past two years has laid down 1,667 miles of highway, and has 1,591 additional miles in various stages of completion. Of this total, 1,089 miles is hard surfaced. The estimated cost is in excess of $48,000,000. This does not take into consideration large projects financed by counties.

NATIONAL LIME ASSOCIATION ORGANIZED FOR EXTENSIVE RESEARCH WORK

The National Lime Association at its Annual Convention in June, has adopted a plan of organization which assures the continuation of its growing program of technical and research work and establishes a stability to the National organization which will make it possible to establish and follow through to conclusion problems of research for the general benefit of the industry.

The National officers and Board of Directors remain as the controlling body, directing the entire research and trade promotional program of the industry, but for the purpose of assuring a continued source of income for all departments of the Association and adding more flexibility to the local field promotional work, the program has been divided into two separate departments; first, the national program of technical research, publicity and national promotion; second, local trade promotional work by men in the field, sub-divided and directed from two division offices with headquarters located at Washington and Chicago.

The members of the Association have agreed on a basis of dues for a period of two years, which will afford the Na-

tional program of technical research work a larger working budget than has been heretofore available, and the members in both the Eastern Division and the Central Division have agreed on a basis of additional dues which allows for a considerable increase in local field promotional work in the two Divisions.

The Lime Association loses the able leadership of Mr. Charles Warner, who has served as its President for the last four years, and who has been primarily responsible for bringing the work of the National Association to its present high standard.

The new President, Mr. George B. Wood, is President and General Manager of the Rockland and Rockport Lime Corporation, of Rockland, Maine. He is a technically trained engineer, having received his degree from the Massachusetts Institute of Technology, has been an active Director of the National Association, and has added much to the lime industry in the way of technical advancement. He is a most enthusiastic believer in the future growth of the lime industry as the result of technical research and development, and is happily chosen as a successor to Mr. Warner.

Mr. William R. Phillips, the former General Manager of the Lime Association, has resigned to take the position of Vice President and General Manager of the American Lime & Stone Company. The Headquarters office and organization is now working under the management of Mr. Burton A. Ford, Acting Secretary, who carries along the work well qualified by his experience during the last year as Mr. Phillips' assistant at the Washington office. Mr. Ford is a technically-trained man, receiving his degree from the University of Maryland. Prior to joining the Association staff he was a Division Manager of the Virginia-Carolina Chemical Company and Secretary-Treasurer of the Bryant Fertilizer Company.

Dr. M. E. Holmes has resigned from the technical staff of the Association, and Dr. G. J. Fink has been appointed Chemical Director. Dr. Fink is a graduate of Wabash College and was for six years instructor in Chemistry at Cornell University, where he received his Ph. D. degree in 1914. He was also Professor of Chemistry at Iowa State College, and for five years prior to coming to the Lime Association was Research Chemist for the Hooker Electrochemical Company. Dr. Fink has been with the Association staff for two years, and is well qualified to assume the direction of the chemical and research problems.

In addition to work at the Association Laboratory in Washington, the Lime Association is supporting at the present time, fellowships in five leading technical institutions where various special problems of investigation and research work are being carried through to conclusion. Co-operative relations also exist with other institutions where important research on lime problems is being conducted. The increased budget for this class of work will make possible, under the two-year program, the completion of the many problems on hand, and the inclusion of new important problems.

The personnel of the National Lime Association is as follows: President, George B. Wood, Rockland, Me.; Vice President, Fred Witmer, Woodville, O.; Treasurer, Milton McDermott, Knoxville, Tenn.; Board of Directors—A. N. Griffing, Danbury, Conn.; C. J. Curtin, New York, N. Y.; George LeGore, LeGore, Md.; O. J. Vanderpool, New York, N. Y.; Warner Moore, Richmond, Va.; J. J. Urschel, Toledo, O.; F. M. Pinnegar, Cleveland, O.; Morgan Curtis, Petoskey, Mich.; B. L. McNulty, Chicago, Ill.; Col. C. W. S. Cobb, St. Louis, Mo.; R. C. Brown, Oshkosh, Wis.; J. M. Gager, Chattanooga, Tenn.; J. F. Pollock, Kansas City, Mo., and H. Dittlinger, New Braunfels, Tex.

Headquarters Staff: Burton A. Ford, Acting Secretary; R. C. Towles, Office Manager; Dr. G. J. Fink, Chemical Director; W. A. Freret, Consulting Engineer; J. A. Slipher, Soil Technologist; R. P. Brown, Construction Engineer.

Eastern Division (Division Office, Washington, D. C.): Henry M. Camp, Division Manager; R. C. Parker, Agronomist; W. F. Campbell, Construction Engineer; W. F. Beyer, Construction Engineer, and W. D. Steward, Construction Engineer.

Central Division (Division Office, Chicago, Ill.): G. B. Arthur, Division Manager; L. B. Burt, Chemical Engineer; A. B. Giett, Construction Engineer; W. H. Magee, Construction Engineer; C. O. Dowdell, Construction Engineer; A. C. Hamilton, Jr., Construction Engineer; L. E. Johnson, Construction Engineer, and O. A. Wakeman, Construction Engineer.

ELECTRICAL APPARATUS FOR NEW SEATTLE SUBSTATION

With its Skagit River development well under way, the City of Seattle has begun the erection of a large substation, known as the North substation, to serve the receiving end in the city for the development. The new station will be located in the residential part of the city and is designed to harmonize with its surroundings.

There will eventually be installed in the substation a maximum of six banks of transformers with the necessary synchronous condensers and switching equipment. The ultimate installation will be fed from the Gorge plant on the Skagit River through two transmission lines approximately 100 miles in length, designed to transmit 90,000 kv-a., three-phase, 60-cycle current at a receiver voltage of 154,000 volts. The transformers feeding the lines at the generating station are rated at 165,000 volts and have permanently grounded neutrals.

The initial installation will include the equipment for one incoming transmission line at 154,000 volts, one transformer bank, and one 15,000 kv-a. synchronous condenser. An order for this apparatus has been placed with the Westinghouse Electric & Manufacturing Co. and it is now in course of construction. An electrostatic glow meter will be used for synchronizing on the 154,000 volt side. The stepdown transformer bank has three 10,000 kv-a. transformers with tertiary windings. Both the 154,000 and 26,000 volt lines are connected with permanently grounded neutrals. The 26,000 volt side is connected to a bus section on which there are three feeders. In the future, each transformer bank will have a 26,000 volt bus section, all the sections to be tied together through reactors. At the present time two sections with a total of six feeders will be tied together without reactors and will be fed from the one transformer bank.

The tertiary windings of the transformers are connected in delta at 6,300 volts and are connected to the 15,000 kv-a. synchronous condenser wound normally at 6,600 volts. Taps are brought out of the transformers for starting the condenser.

The high tension oil circuit breakers are Type G-2, 400 ampere, 154,000 volts; the 26,000 volt breakers are type CO-2, 1,200 amperes with mufflers; and the breakers for use with the 6,600 volt condenser are type CO-11, 1,600 amperes, 25,000 volts.

The auxiliary equipment consists of a 300 kv-a. transformer bank; a 100 K.W. motor generator set to be used for an extra exciter, for operating a crane, or for charging the storage battery in an emergency; a 7½-K.W. battery charging set, and a 60-cell storage battery for control purposes.

A type D-3 benchboard having a relay board in the rear with grill work at each end will be supplied. This desk will be used for controlling the condenser and the incoming line and is drilled for future apparatus for controlling the second line and the tie breaker between the two lines. A switchboard consisting of two switchboards mounted back to back with grill work between will be provided for controlling the 26,000 volt feeders and the voltage regulator equipment for the condenser.

There will also be a temperature indicating board for indicating the temperature of the coils in the condensers and the temperatures in the individual transformers; a station service board for controlling the storage battery, station light and power spare motor generator set, and other miscellaneous circuits; a field control board, and a crane panel. Differential protection will be provided for the condenser and for the entire transformer bank. The 154,000 volt incoming line will be protected with type CR relays and a ground relay.

TENNESSEE COUNTY DEVELOPS SUCCESSFUL TYPE OF ROAD

The highway department of Davidson County, Tennessee, where Nashville is the county seat, has developed an economical and successful type of road by salvaging with surface treatment, 215.8 miles of old gravel and waterbound macadam. These roads, according to J. G. Creveling, chairman of the Davidson County Highway Commission, comprise 26 per cent of the county system and carry 90 per cent of the traffic.

"We have been resurfacing our old macadam and gravel roads," says Mr. Creveling in a report to the Nashville Chamber of Commerce, "with a substantial thickness of waterbound macadam, being rather sparing in the use of fine

aggregates and rolling the coarse stone before adding the fines. After permitting travel to use the road until well compacted and the excess fines whipped off, we apply one-half gallon of heavy Mexican asphaltic road oil, which is immediately covered with a special crushed river gravel about 400 yards per mile of twenty foot width.

"We utilize every bit of value in our old roads and we build from start to finish without detouring travel. The cost is lower, we can make more progress and it stands up well under our travel which on certain roads, averages 2,000 vehicles per day. Roads built during 1916-1917 and on to date are still in fair condition without reoiling. Immediately after a road is completed it is placed in charge of a patrolman who gives it regular attention. One man with a mule and wagon takes care of about 20 miles of oiled road. This work costs about $150 per mile per year for labor and material used.

"As the surface treated road gets rough or wavy we find that it can be scarified, reshaped and reoiled at a nominal cost and by using one-fourth gallon, instead of one-half gallon as originally, it is really better than when first treated. We have reoiled less than 10 per cent thus far. We estimate on our main roads, which average from 800 to 2,000 vehicles per day near the city down to 200 near adjoining counties, that it costs less than one-half a cent per vehicle mile to build and maintain this type of road."

TWO REEL FILM SHOWING MANUFACTURE OF CEMENT NOW AVAILABLE.

Much of the unusual equipment involved in making cement is interestingly illustrated in a two reel moving picture called, "The Story of the Manufacture of Portland Cement," just released for general showing.

Starting with views of one of the large plants in which the country's cement is made, the film pictures in a non-technical way the essential steps in transforming thousands of tons of raw materials into Portland cement. Scenes taken at a number of plants are included.

From the moment that a great blast breaks loose a cliff of limestone in the quarry to the time when the finished cement goes into storage in big concrete bins, the process of manufacture is almost entirely mechanical—otherwise present day outputs would be impossible.

In addition to straight photography, animated drawings have been inserted to make clear what occurs inside the grinding mills, what goes on within the white-hot interior of the huge kilns, and how the cement sacks, suspended upside down, are filled after they have been tied.

This film can now be secured without charge by interested organization through any office of the Portland Cement Association, or from Association headquarters at 111 W. Washington St., Chicago.

EVINRUDE HIGH PRESSURE PUMP IS ADOPTED FOR FIRE FIGHTING IN SANTO DOMINGO

The city of Santo Domingo, in the West Indies, whose 20,000 inhabitants have heretofore been entirely without fire protection, has decided to purchase an Evinrude high pressure pump after a successful demonstration of its efficiency before a group of the city's leading men including the Mayor, the Chief of Police, the President of the Chamber of Commerce and the Governor of the Province of Santo Domingo.

There being no aqueduct or other source of water supply apart from rain water cisterns, a regular fire department is out of the question in Santo Domingo. However, it is thought by placing three or four Evinrude high pressure pumps at various points of vantage throughout the city, it will be possible to combat disastrous fires of which there have been several during the past few months.

This pump is powered by an Evinrude two cylinder 2 cycle 4-5 H. P. gasoline engine with the Evinrude built-in-flywheel magneto, gravity feed carburetor and easy starting device. This engine is direct connected to a Viking 1½-in. special type high pressure pump. Both are compactly mounted on a strong aluminum base, the total weight being only 99½ lbs. It is especially designed for use in industrial plants, small towns and isolated institutions and for fighting forest fires and general fire service in lumber yards. Although designed to pump against 120 lbs. pressure, in demonstrations it has greatly exceeded its rated capacity, the pressure gauge showing an average of 150 lbs. and at times reaching the high pressure of 180 lbs. per square inch.

With ¼-in. nozzle this pumping outfit

has thrown an 80 ft. stream with a pressure of 170 lbs. In another test the pump was stationed 175 ft. above the water level and through 1,500 ft. of 1½-in. hose and with ¼-in. nozzle it threw a 50 ft. stream with a pressure of 140 to 160 lbs.

SPECIAL TRAFFIC STUDY IN DETROIT

The special traffic conditions of the northern part of Detroit, centering in Highland Park, the site of the Ford motor works, are being studied by J. Rowland Bibbins, Consulting Engineer on Transportation, 921 Fifteenth St., N. W., Washington, D. C. This situation has been growing in complexity along with the City itself, due to lack of adequate development of streets, transit lines, terminals, etc., combined with the rising flood of motor traffic, buses and de luxe jitneys.

The Ford motor works employed 14,000 men in 1914, 31,000 in 1916 and employs 70,000 today, with practically the same street car lines and terminals existing today as in the pre-war period.

In ten years, with the development of the Ford industry, the population of this district has increased 1,000 per cent, with 60,000 people now housed in less than three square miles of area.

Perhaps nowhere in the United States is a city confronted with the problem of transportation facilities for 70,000 workmen in one factory with 33,000 on one shift, and with a single main thoroughfare conveying cars at 20-in. headway, motors at 2-in. and pedestrians at 0.2-in. headway.

Thus the Highland Park District has grown to be the traffic key of the City on the north. Mr. Bibbins will embody in his report to the city council a broad consideration of streets, railroads, interurban development and special transit terminals as well as specific recommendation for immediate remedies in traffic control. In this work, the co-operation of various officials and traffic agencies of Detroit has been enlisted, as the problem is viewed as more regional than local.

BLACK PAINT FOR TRAFFIC MARKS

The paint department of the Du Pont Company announces the development of a traffic black for marking purposes in the regulation of traffic. This is in addition to the traffic white, which is already being manufactured. The new black is the result of co-operative experiments with a number of cities, and has been developed to meet the needs of cities and counties which are using this color for traffic control.

The new paint dries dust free in 15 minutes, tack free in 30 minutes, and in from 5 to 6 hours dries to a hard, elastic film. After being in daily use for 10 weeks, it still retained its durability and color, and was in every way satisfactory.

VALUABLE TRADE LITERATURE

(Copies of this literature may be obtained by writing to the addresses given in the reviews or to this magazine.)

Electric Lighting Equipment—The Westinghouse Electric & Manufacturing Company has issued two new catalogues on electric lighting equipment: Catalogue 8-A on Overhead Street Lighting Equipment and Catalogue 8-B on Ornamental Street Lighting. The first catalogue contains 72 pages and the second 68, and both are fully illustrated with photographs and line drawings. In addition to the lighting equipment itself, the catalogues contain a complete descriptive list of accessories such as cables, potheads, mast arms, cut-out pulleys, etc.

Swimming Pool Sanitation—A bulletin of 16, 8½x11-in. pages has been issued by the Graver Corporation of East Chicago, Ind., on the Graver recirculating and refiltering system for maintaining a hygienic water in swimming pools. Information is given for designers of pools.

Truck Cranes—The many time and money-saving uses of the Byers Truckrane are illustrated and described in a bulletin of 16, 8½x11-in. pages just issued by the Byers Machine Co. of Ravenna, Ohio. This Truckrane is an industrial crane designed to be mounted permanently on a motor truck chassis. The bulletin tells just what it is, how it operates, and gives all the data requisite to a complete understanding of this piece of equipment and its uses.

Pumps—A new style of centrifugal pump, called a "series pump," is described in a catalog just issued by the De Laval Steam Turbine Co., Trenton, N. J. In this pump, double suction im-

pellers and volute diffusers are used, as in single stage centrifugal pumps. The connecting passages from stage to stage, however, are included in the pump case casting, as in the ordinary multistage pump. The advantages claimed are perfect hydraulic axial balance and high efficiency under varying loads, as is characteristic of the single stage pump. These series pumps are made with two or three stages. Where more than three stages are required, the use of two independent pumps operating in series and mounted on a single base plate is recommended in order to keep down the length of shaft between bearings.

Steel Joist Construction—The use of Steel Joist Construction in light-occupancy buildings has made rapid advances recently. Its fireproofness, economy and simplicity are not generally recognized; hence the demand by architects, engineers, contractors and builders for accurate data on design and construction. The Truscon Steel Joist Data Book, as its name implies, is a handbook of information. It presents in concise, convenient form the essentials, tables for designing, specifications and details, so that the man who has the book can lay out and design a complete steel joist installation. The book is issued by the Truscon Steel Co., Youngstown, Ohio. This Data Book is profusely illustrated so that photographs and drawings practically tell the whole story. Tables of carrying capacities and properties are set in large bold type so that they are easily read and are conveniently arranged for use. The front part of the book is devoted to a description of the essential features and to a photo gallery of 32 views of different installations. The field covers apartments, residences, schools, public buildings, hotels, hospitals, stores, offices, clubs, university buildings, theaters, factories and garages. Following these are the sections of properties of the different types of joists, Hy-Rib and channels. The safe loading tables give the carrying capacities and individual beams and for the floor itself with various joist spacings. Useful information on weight of floors, bending moments and deflection of beams for various methods of loading and co-efficients for deflection, follow. Specifications for Steel Joists are comprehensive. Isometric drawings of floor and partition details are given. The various accessories used with Steel Joists, such as joist clips, screed clips, hook staples, etc., are shown in application. The remainder of the book is devoted to details covering the use with structural steel, masonry walls and reinforced concrete; also details of framing around openings, installation of pipes and conduits, suspended ceilings, balconies, grandstands, roofs and stairways. On the last page is a typical floor plan with details of the use of joists for first floors of residences.

Bates Experimental Road Tests—"The Story of the Traffic Tests on the Bates Experimental Road as Told by the Camera," is the title of a pamphlet of 16, 9x12-in. pages issued by the Portland Cement Association, 111 W. Washington St., Chicago. The bulletin places at the disposal of engineers and officials the facts and conclusions obtained from the Bates Road Tests. In addition to numerous pictures it contains a description of the road, tells how the traffic tests were made, and gives the summary of conclusions of the engineers in charge of the tests.

Tractor—The Holt 10-ton "Caterpillar" tractor, of 40 drawbar h.p. is illustrated and described by a folder issued by The Holt Mfg. Co., Inc., Peoria, Ill. Full specifications are given.

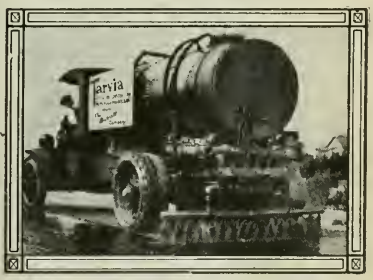
Asphalt Tool and Surface Heaters—The Chausse line of oil-burning tool and surface heaters for repairing asphalt pavements is fully illustrated and described in a pamphlet of 8, 7½x10½-in. pages, issued by the Chausse Oil Burner Co., 206 Lincoln Bldg., Detroit, Mich.

Trailers—The LaPlant-Choate tractor trailers are adequately illustrated and described in a pamphlet of 4, 9x12-in. pages issued by the LaPlant-Choate Mfg. Co., Cedar Rapids, Iowa. These trailers are used on many large jobs to reduce hauling costs.

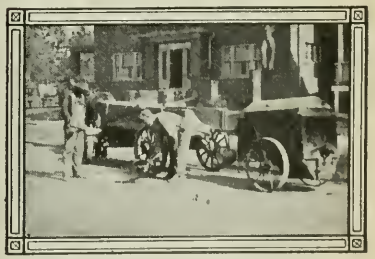
Material Testing Machines—The Tinius Olsen testing machines for testing road-building materials are illustrated and described in an attractively printed folder issued by the Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia, Pa. These machines show the strength and other qualities of cement, concrete, brick, pipe, sand, stone and various other road-building materials. Tests for compression, tension, shear and transverse strengths are readily made. Qualities of resistence to penetration, impact, abrasion, expansion and contraction are easily ascertained.

Patching surface breaks on suburban highway with Tarvia

Surface-treating with Tarvia and pea-gravel covering over brick pavement



arvia maintenance Truck app ying Tarvia



Patching macadam street with Tarvia

"Eternal Maintenance is the Price of Good Roads"

TODAY Road Engineers and well informed laymen realize that eternal maintenance is the price of good roads. For experience has conclusively demonstrated that *every* type of modern road or highway requires regular, systematic upkeep if it is to withstand the grinding wear of modern traffic.

And every type of improved road can be satisfactorily and economically maintained with Tarvia. Hundreds of cities, towns, and rural communities throughout the United States and Canada employ Tarvia maintenance on all their streets and highways.

Not only is Tarvia preeminent as a road-building material, but it is made in special grades that are unequalled for reconstructing, repairing and maintaining all types of improved roads. Tarvia keeps every type of good roads good, at minimum cost and with minimum interruption to traffic.

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Combustion Equipment—The Combustion Engineering Corp., Broad St., New York, N. Y., has issued a pamphlet giving a condensed description of all their products, including the Frederick stoker, Lopulco pulverized fuel systems, Coxe traveling grate stoker, Quinn fuel oil burner, Lopulco coal dryer, ash conveyors, chain grate stokers, preheaters, grates, oil torches, etc.

Water Works Supplies—The "Michigan" line of water works supplies is described in a 12-page pamphlet issued by the Michigan Valve and Foundry Co., Detroit, Mich. This is the "Flower" line and includes: fire hydrants, water gates, valve boxes, sleeves, valves, indicator posts, sluice gates, check valves, foot valves, grey iron castings, etc.

Heavy Duty Pavers—The Koehring line of Heavy Duty Pavers is illustrated and described in detail in catalog No. 24, recently issued by the Koehring Co., 31st and Concordia Sts., Milwaukee, Wis. This is a very handsome catalog of 48, 8x11-in. pages and several folding plates illustrating the various pavers in this line. All the special features of design and construction are fully explained and pictured. There are numerous interesting views of the pavers in action on the job.

PUBLICATIONS RECEIVED

Recommended Building Code — The Portland Cement Association has contributed to the movement for better building codes a compilation of the latest available information relating to building construction. This compilation is in the form of a Recommended Building Code for cities of 25,000 to 150,000 population. This code, which is based upon a study of a large number of America's building codes, including the code of the Industrial Commission of Wisconsin, has already been adopted in its entirety, or with only minor changes, by a number of communities. In the hands of those engaged in studies of existing codes this Recommended Code will prepare the ground for an intelligent revision and will save a great deal of time and effort. Copies may be obtained by addressing Portland Cement Association, 111 West Washington St., Chicago, Ill.

Concrete Data for Engineers and Architects—This is a booklet of 16, 8½x11-in. pages, dealing with certain important factors in making good concrete. It is issued by the Portland Cement Association, 111 West Washington St., Chicago. The principles set forth in it are based on data compiled from many thousands of tests made at the Structural Materials Research Laboratory, under the direction of Prof. D. A. Abrams, at Lewis Institute, Chicago. The essential principles embodied in this booklet are: Well-graded aggregates, less mixing water, proper and complete mixing, careful placing and proper curing, or protection, after placing. These principles are important to all upon whom the duty of making concrete may depend, but the relation of one to the other or of any individual principle to the resulting mass, has been many times overlooked. A study of these essentials will convey in a short, concise manner, the practical application of Professor Abram's principles. The use of any one of these will make a better concrete, more resistive to the loads imposed or conditions met. They make for greater usefulness of concrete without materially affecting the methods commonly used in construction. The two factors most often neglected and the ones representing the greatest sacrifice in ultimate strength of the concrete are: Too much mixing water and the lack of protection, or curing, of the newly placed concrete.

Sewage Works Operation — The proceedings of the New Jersey Sewage Works Association for 1922 and 1923 have been published and make a booklet of 32, 7½x10½ pages. In addition to the minutes of the seventh and eighth annual meetings, there are papers and discussions on the following subjects: Operation of Pennypack Creek Sewage Treatment Works, Philadelphia; Progress Report on the Sewage Experiment Substation, New Brunswick; Maintenance of Sewer Systems; Some Sewage Experimental Work Accomplished and Under Investigation at the Sewage Substation, New Brunswick; The Licensing of Superintendents and Operators of Sewage Treatment Plants in New Jersey; Superfluous Sewage Treatment Works; Odors from Sewage Disposal Plants. Also there is given the Constitution of the Association and a list of its officers and members. This is a valuable booklet for sewage works operators, city officials and engineers. Nonmembers may obtain copies at $1 each by writing the Secretary of the Association, Mr. Myron E. Fuller, 36 E. Mt. Airy Ave., Philadelphia, Pa.

EDITORIALS

ONE ENGINEER WHO GOT CREDIT

In this issue the story of how one engineer got, and will continue to get, credit for his work is related. The article is entitled: "The O'Shaughnessy Dam and Its Dedication." There is much in it to entertain and instruct the reader. While considerable engineering information of value is given it is because of the human interest of the story that it is recorded in our pages. The article is of value also for its account of the pulling and hauling indulged in for many years between the interests who favored and those who opposed the Hetch Hetchy project. The article, while long, is intensely interesting. Its reading suggests many lines of thought which we leave for our readers to discover according to their several abilities in the realm of discovery.

THE TAX BURDEN

We read much these days of the burden of taxation. That taxes are high no one will deny, but there is much to be said in justification of present high taxes and of prospective higher taxes.

It is only natural that where discussion of a subject is long continued the discussion increases in intelligence as it progresses. This is true of the discussion of taxation. Newspaper editorials on the subject are growing fairer and better. This is due, in part, to the fact that when a newspaper's pet politician or pet party gets into power on the strength of impossible promises of lower taxes and then is obliged to increase taxes the newspaper has no way out but to justify the increase and to show why it is inevitable. Since taxes started to increase almost everybody has had a chance to reduce them but the result has been the same in all cases, namely, a large or small increase each year over the year before. And so it has come about that those who make any pretense of sincerity are getting away from the calling of hard names and are getting down to serious study of the subject and to honest effort to make the whole problem better understood.

As we understand it, taxes have always been a "burden," fancied or real. This was true when taxes were insignificant compared with what they are today. A man dislikes to pay his taxes because he is handing over some of his money for somebody else to spend. He will cheerfully squander many times the amount of his taxes and have a perfectly fine time doing it even though he is positively injured in the process. But he has not been taught that government takes some of his money and spends it for him, to his advantage, better than he could do it for himself. Such abuses as exist in the levying of taxes, and they have been many and long continued, have been due to the unwillingness of the people to understand the need for and purpose of taxation. For this reason taxes have always been as indirect as they could be made. They have been covered up in a thousand clever ways so that a man might pay them painlessly. The trend toward direct taxation is the most encouraging evidence of progress in this matter. Thus we have the income tax, the gasoline tax, the meter rate in utility service, all forms of direct taxation, and, generally speaking, fairly popular where understood.

In the past the ideal tax from the standpoint of the citizen has been a tax he escaped and the other fellow paid. The ideal tax from the standpoint of the public official has been one which could be collected easiest, that is, with a minimum of unpleasant noise and at the expense of as few new political enemies as possible. Thus Mr. Baldwin, British prime minister, recently said that while theoretically taxes were levied according to ability to pay, actually they were based on "getting the greatest quantity of feathers from the geese which squawk the least."

Almost every kind of experiment has

been tried repeatedly in the effort to extract taxes painlessly. There have also been many freak laws tried. It is said that England once tried a window tax. The owner of property paid taxes according to the number of windows in his house; then men, as reluctant then as now to pay taxes and as desirous of evading them, began building houses with fewer windows, with concealed windows, and even with no windows at all. This killed the window tax and probably something equally silly was next given a trial.

The luxury tax has always been highly regarded by the tax layers. About 40 years ago the bulk of the revenue of the United States government came from what President Garfield called "volunteer taxes." They were imposed on liquor and tobacco and only those who used liquor and tobacco paid. The decision rested with the citizen whether he should make himself liable and it is not recorded that many elected to evade payment of the tax. Those who wanted tobacco would have it at any price, even if a small part of the price went to the government in the form of a tax. The same was true in the case of liquor, only, perhaps, more so, for after a man had had a couple of drinks he became so generous that he did not mind giving his money away, even if the government got a little of it. The rest of the federal tax at that time came from the tariff which was popular, then as now, because those who paid it didn't know they paid.

Some may be inclined to question the statement made earlier in this discussion that there is a trend toward direct taxation and that it is popular. Take the case of the income tax. The first income tax law was enacted in the second Cleveland administration; it was declared unconstitutional. During the sixteen years following, with the other party in power, the law was allowed to remain dead. With the return to power of the party of Cleveland another federal income tax law was passed which still remains on the statute books despite the fact that the opposition party has again come into power and has had full control of the government for over two years. This shows clearly that while many are bitterly hostile to the income tax and while very few enjoy paying it, that it is considered fair in principle by such a large majority of the people that its repeal is not seriously considered at this time. Then there is the gasoline tax that requires a man to pay in proportion to his use of the highways. This is spreading rapidly despite serious opposition when it is first proposed in any state. After trying this tax it is approved almost universally. A direct tax, fairly levied and fairly collected, is no longer repugnant to a majority of the American people.

Of course the war, directly and indirectly, greatly increased our taxes and this influence will continue to keep taxes up for a good many years, even though we do not have another war in the meantime. But of equal, or greater, importance is the fact that people are demanding more and more improvements of all sorts and more service from government, thereby inevitably increasing taxes, especially so when taxation is openly rather than covertly levied. Many are becoming reconciled to this in the recognition of the fact that we must pay for what we get, even if we get it from or through the government. Being unwilling to accept less but, rather, demanding more and more, it is coming to be realized that the day of low taxes, as once understood, is not likely soon to return. A saner view and a more wholesome philosophy, with respect to taxation, meanwhile is rapidly gaining headway. Without becoming lighter the tax burden may become less galling.

A REJECTED ADVERTISEMENT

Not long ago a well known secondary city in the Middle West offered for publication in this magazine an advertisement addressed to consulting engineers inviting them to indulge in a bidding tournament as a preliminary to the selection of one of them to serve the city in a consulting capacity. While we do not want to deny any city the benefits to be derived from advertising in this publication we felt that here the welfare of the engineering profession was paramount and rejected the advertisement. A letter was also written to the official who submitted the advertisement which attempted to discourage further recourse to this method of selecting a consultant. This note will serve as notice that all advertisements calculated to encourage consulting engineers to bid against each other will be rejected by this magazine. That practice is so likely to lead to poor or dishonest work, or both, that we do not wish to encourage it in any way.

SHOULD THE STATE PURCHASE SMALL TOWN BOND ISSUES?

By Keyes C. Gaynor, Consulting Engineer, 525 Trimble Bldg., Sioux City, Iowa.

Small communities often find it difficult to finance the necessary modern conveniences, such as sanitary sewers and water works.

In many such towns these improvements are absolutely necessary from a sanitary point of view. Further, the small town at the present time has the fight of its life to retain its population and its business in competition with its larger neighbors already provided with modern improvements. The farmer of today who retires from the farm goes to that town where he can live in the greatest comfort.

The bond issues necessary to cover the cost of sewer and water works improvements are small and in many states, the legislature has limited the interest rate to 5% and further provides that the bonds must be sold at par. From the nature of things, it can be readily understood why the bond houses are not attracted to these issues. It costs just as much to handle a small bond issue as it does a large one. Therefore, the price of the small issue must be higher.

It has occurred to the writer, although he does not claim that the idea is original with him, that it would be of great advantage to the small town and also to the bond buyer, for the state legislatures to establish state financing departments, the purpose of which would be to buy the bond issues of the small towns and in turn issue bonds guaranteed by the state.

What Has Been Done in Nebraska

For instance, the State of Nebraska has accumulated many millions of dollars of so-called school funds. These funds have been invested in various ways, sometimes in bond issues of other states. Of late years, they have been investing these school funds in municipal bonds. During the years 1920-21 when the bond market collapsed, this was a wonderful aid to the small towns, and sometimes the towns were not so small either. Throughout this period, towns in Nebraska were able to carry out their construction programs and pay for them because the State bought their bonds

Need Shown in South Dakota

To show how such a plan would work, attention might be called to a case that recently came under the writer's observation. The City of Springfield, South Dakota which has a population of about 800 people recently voted $8,000 worth of water works bonds. Springfield is located in one of the best farming communities in South Dakota. The Southern State Normal School is located there. The town water supply has been derived from an artesian well. This supply is giving out and water must be obtained from some other source. When they advertised their bonds for sale, they could not get a bid which would conform with the law. Eastern bond buyers had never heard of Springfield, South Dakota, and could not take time to go out there and investigate so small an issue. If it had been possible for Springfield to sell these bonds to the State, the State of South Dakota could have turned around and sold State bonds, because everybody knows where the State of South Dakota is and what it is.

The carrying out of such a plan as suggested would not be a burden on the state, because the state could either sell 5% bonds at a premium or they could sell 4½% bonds and charge the town 5%. The difference in rate would provide money for the maintaining of the state financing department.

Such a plan as I have suggested would be welcomed by the small town and, I think, would be greatly appreciated by the bond buyers.

A DIFFERENT ANGLE ON THE SUB-DRAINAGE OF PAVEMENTS

By Monroe L. Patzig, Consulting Engineer, Patzig Testing Laboratories, Des Moines, Iowa.

Repeatedly our attention has been called to the necessity of providing adequate drainage for the soil underneath pavements. It doesn't seem, however, that this advice has been followed out to any great extent on municipal pavement construction. In certain localities at least, less drainage has been provided in recent years than was the practice, say, 15 years ago.

At that time crushed stone or gravel sub-drainage was required underneath the pavement foundation of concrete. In these same cities present day paving work is being placed directly upon the sub-soil no matter whether it be clay, loam, sand or other material. It was then also customary to require this type of drainage underneath sidewalks, curbs, etc.

There seems to be no dispute regarding the advisability or necessity of drainage excepting on the matter of determining

the actual necessity on each specific job. There is no positive method of determining when this added expense is necessary and economical. Necessity of sub-drainage is now largely determined by judgment of the soil conditions or a knowledge of the past behavior of the soil in question, which means that we are without adequate evidence, in most cases, to prove that sub-drainage will overcome certain destroying agencies and its expense is warranted.

Over a period of 20 years, actively engaged in pavement construction, the writer has had before him but one case where a systematic drainage system was provided. In this instance a system of drain tiles was laid in conjunction with the paving construction. It was afterwards necessary to prove that the drainage was necessary and could therefore be assessed as part of the pavement. An examination of the drainage outlet at a period several weeks after there had been any rainfall, revealed a flow of 5 ins. of water through the 20-in. outlet tile. From personal observation this soil did not appear to need drainage nearly so much as the pavement construction in many other localities where no drainage whatever was provided. This system of drainage was provided through the efforts of the engineer in charge, whose only proof as to its necessity was his judgment.

The effects of moisture in the soil have generally been recognized as causing a poor or yielding foundation, and upheavals, on account of frost or freezing.

Expansion due to moisture is still another effect, but given much less attention than the two mentioned.

My attention has often been called to cases of concrete pavements built during recent years, that had been badly warped. In most instances slabs of the pavement would be from 1 in. to 5 ins. higher than the adjoining slabs, and some of them were found to be curved or bent upwards as much as 3 ins. from a straight line.

Frequent examples exist where concrete used for pavement bases under such types of pavement as asphalt, brick, wood block, etc., have blown up and caused humps in the wearing surface. Some instances of these were actual explosions while most of them simply shattered the concrete underneath and caused unpleasant and objectionable humps in the pavement.

The causes of these disturbances had been attributed to heat expansion or frost action. I say heat expansion because where it was said to be due to expansion the only remedies suggested were to use expansion joints. If expansion due to moisture had been considered would it not be more effective to guard against the moisture or in other words, remove the cause? Surely this would be more positive, effective and practical.

Tending to substantiate this opinion let us consider the numerous instances of buckling experienced on asphaltic types of pavement, brick laid on sand cushion and other similar types. The concrete base in these instances is protected from the direct rays of heat, consequently there can be less possibility of heat expansion than of moisture expansion.

Also referring to the defects mentioned in the concrete pavements it appears that frost action would not cause the raising of one slab end over the adjacent one but would cause the two slab ends to come up instead of the one. Also temperature expansion would not cause one section rising over the other unless there was a distinct defect in making the joint by not making it perpendicular. But with moisture expansion there is a decided tendency for the concrete slabs to curl upwards due to the greater expansion on the lower surface than on the upper one.

This curling action can be more pronounced in concrete pavements than on the concrete base used under other types of pavement surfaces, because there can be a greater difference between the moisture or humidity of the two surfaces thereof.

Many sidewalks also show signs of this peculiar expansion and curling action.

In discussing this theory my attention was called to a cement slab which was carefully straight-edged during construction and was placed in a wall where dripping water had kept the backside thereof wet. In about a year's time this slab was discovered to be curved away from the wall.

The defects of concrete pavements and concrete foundations mentioned seem to occur more frequently in certain locations than in others. This is possibly due to the differences in soils and their water retaining tendencies.

They are also usually found to occur more frequently in cities and towns than upon highway pavements. This may be due to the fact that construction methods in cities and towns require the use of curbs and the ground elevations surrounding the pavement are higher, while standard highway practice permits the construction of open ditches or waterways on each side of the pavement, thereby af-

fording better outlets for the ground water underneath the same. Some of these same defects have, however, been noticed upon highways where wide earth shoulders, sometimes grown over with grass or weeds, were maintained, and the ground water thereby very likely retained under the pavement.

Believing, therefore, that moisture expansion has not been given the thought or study that temperature expansion and frost action have, it has been my purpose to mention this force for the purpose of arousing and encouraging more interest to the importance of drainage, and to create thereby a nation-wide discussion tending to bring about a definite and effective solution of the drainage problem affecting pavement construction.

It seems that a comprehensive study should be made of all kinds of soils tending to establish by some reliable methods of testing to determine the nature or tendencies of any soils to be used, in terms that are definite with respect to their actually requiring drainage or not requiring it. Also determination should be made with respect to the proper methods to be used for draining any such soils, effectively, efficiently and economically.

Realizing the extravagance of providing crushed stone, gravel or drain tile systems wherever clay soils are encountered, it is apparent that some exhaustive examinations, tests, analyses, research and discussion should be carried out in order to attempt a solution.

ILLINOIS COUNTIES JOIN STATE IN EXPERIMENTAL STUDY OF OILED ROADS

By H. F. Clemmer and F. L. Sperry, Engineer and Assistant Engineer of Materials, Illinois Division of Highways, State House, Springfield, Ill.

The Illinois Division of Highways in co-operation with the highway authorities of Henry and Christian Counties has started an exhaustive series of tests with the use of oil for the treatment of earth roads.

Soil and Climate Range

The construction of two experimental oiled roads has just been completed. One of these roads is located in the northwestern part of the State near Cambridge in Henry County. The other is located one mile from Rosemond near Pana in the south central portion of the State. These locations have been selected with the view of securing the fullest range of soil and climatic conditions which exist between northern and southern Illinois. The location of the experiments is believed to be of much importance because experience has indicated that both soil and climatic conditions are important factors in the life of an oiled earth road.

The Test Roads

The Cambridge Test Road is about 3 miles in length and comprises 15 sections, each 1,000 ft. in length. The Rosemond Road is about 2½ miles in length and comprises 16 sections, each 800 ft. long. Each of the 31 sections making up the two roads has been given a different oil treatment. Eleven different kinds and grades of road oil, including all available commercial varieties of oil having been used. Fourteen sections employing varying quantities of oil and numbers of treatments, varying from 1 quart per sq. yd. applied at one application to 1 gal. per sq. yd. applied at intervals throughout the season, have been constructed. Other sections have been constructed employing varying methods of maintenance and application of oil.

Both of the experimental roads are now open and subject to normal traffic conditions. The Rosemond Road is subject to only comparatively moderate traffic whereas the Cambridge Road carries a heavy automobile traffic. The roads are under close observation and their behavior will be carefully watched and the results of traffic recorded.

It is hoped by these experiments to secure much valuable data on the use of oil as a means of maintaining earth roads under conditions which exist in Illinois.

Experiment With Oil Applied in Varying Quantities and Numbers of Treatments

This series of tests occupies a total of 13 sections of both roads and covers the full range of treatments ordinarily used on dirt roads in Illinois, beginning with a minimum treatment of 1 quart per sq. yd. to a maximum of 1 gal. applied at intervals throughout the season. The same kind of oil was used throughout this series of tests except that the oil used at Cambridge was of a heavier grade than that used at Rosemond.

Descriptions of the individual sections follow:

Section 1-R*. Initial treatment, ¾ gal. per sq. yd. in three application. No further applications will be made on this section throughout the year. †Oil No. 1-R used. Total treatment, ¾ gal. per sq. yd.

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* "R" refers to the Rosemond road and "C" to the Cambridge road.

† For analyses and descriptions of oils see Table I.

Section 2-R. Initial treatment, ¾ gal. per sq. yd. in three applications to be followed by one similar application in the fall. Oil No. 1-R used. Total treatment, 1 gal. per sq. yd.

Section 3-R. Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the fall. Oil No. 1-R used. Total treatment, ¾ gal. per sq. yd.

Section 4-R. Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the late summer and another application in the fall. Oil No. 1-R used. Total treatment, 1 gal. per sq. yd.

Section 5-R. Initial treatment, ½ gal. per sq. yd. in two applications. No further application on this section. Oil No. 1-R used. Total treatment, ½ gal. per sq. yd.

Section 6-R. Initial treatment, ¼ gal. per sq. yd. to be followed by one similar application in the late summer and another in the fall. Oil No. 1-R used. Total treatment, ¾ gal. per sq. yd.

Section 7-R. Initial treatment, ¼ gal. per sq. yd. to be followed by one similar application in the fall. Oil No. 1-R used. Total treatment, ½ gal. per sq. yd.

Section 6-C. Initial treatment, ½ gal. per sq. yd. in two applications. No further applications to be made during the year. Oil No. 2-C used. Total treatment, ½ gal. per sq. yd.

Section 7-C. Initial treatment, one application of ¼ gal. per sq. yd. to be followed by one similar application in the fall. Oil No. 2-C used. Total treatment, ½ gal. per sq. yd.

Section 8-C. Initial treatment, one application of ¼ gal. per sq. yd. A similar application was made on August 8, 60 days after the initial treatment was applied. One further application will be made in the fall. Oil No. 2-C used for initial applications. Oil No. 8-C used for second application. Total treatment, ¾ gal. per sq. yd.

Section 9-C. Initial treatment, ½ gal. per sq. yd. in two applications. A similar application was made on August 8, 60 days after the initial treatment was applied. One further application will be made in the fall. Oil No. 2-C used for initial applications. Oil No. 8-C used for application made August 8. Total treatment, 1 gal. per sq. yd.

Section 10-C—Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the fall. Oil No. 2-C used. Total treatment, ¾ gal. per sq. yd.

Section 11-C. Initial treatment, ¾ gal. per sq. yd. in three applications. No further applications to be made during the year. Oil No. 2-C used. Total treatment, ¾ gal. per sq. yd.

Experiment With Different Kinds of Oil

In this series every commercially available kind or type of oil has been used. Nine sections are occupied by these tests.

By reference to "kind" of oil in these tests is meant a distinct chemical type of oil, according to the process of refining or the geographical source of the crude from which the oil has been prepared. By a "skimmed" oil is meant a residuum from a "skimming" plant, that is a refinery employing non-pressure or straight distillation methods of refining. A "cracked" oil is one which has been refined under the influence of high temperatures and pressures and thus chemically decomposed or "split" up into the lighter hydro-carbons and carbon to increase the gasoline yield. The term "cracked pressure tar residue" is applied to oils refined by a certain cracking process in which the residuum is so altered as to have many of the chemical characteristics of tar. "Mexican asphaltic oil, is oil obtained from Mexican petroleum which has a natural asphalt base and, therefore, is well adapted to road work and the manufacture of asphalt. "Cut-back asphaltic oil" is a Mexican or other natural asphaltic oil which has been reduced or thinned to a working consistency by the addition of light distillate.

All available types of oil in the market have been included in the experiments and the product of any individual refinery will fall into one of the classes of oil under test. To insure fair competition between different oils, each one has insofar as the refiners would supply it been used in equivalent grades, the grading being based on the Specific Viscosity Test at 60 deg. C. and the Solid Residue Test. On the Cambridge Road oils having a Specific Viscosity of as near 21.0 as possible and meeting the Illinois E-3 Specification as to solid residue of 100 penetration were used. On the Rosemond Road oils having a Viscosity at 60 deg. C. of 12.0 and meeting the Illinois E-2 Specification requirements for solid residue were used.

Section 11-C. ¾ gal. per sq. yd. in three applications of cracked pressure tar residue (Oil No. 2-C).

Section 12-C. ¾ gal. per sq. yd. in three applications of cut-back asphalt base oil (Oil No. 5-C).

Section 13-C. ¾ gal. per sq. yd. in

three applications of Mid-continent cracked residuum (Oil No. 4-C).

Section 14-C. ¾ gal. per sq. yd. in three applications of Mexican asphaltic base oil (Oil No. 3-C).

Section 15-C. ¾ gal. per sq. yd. in three applications of Mid-continent skimmed oil (Oil No. 1-C).

Section 11-R. ½ gal. per sq. yd. in two applications of Mid-continent skimmed oil refined from Illinois crude (Oil No. 3-R).

Section 12-R. ½ gal. per sq. yd. in two applications of Mid-continent skimmed oil refined from Arkansas crude (Oil No. 5-R).

Section 13-R. ½ gal. per sq. yd. in two applications of blended Mid-continent skimmed and Mexican asphaltic base oil (Oil No. 4-R).

Section 14-R. ½ gal. per sq. yd. in two applications of Mid-continent cracked oil refined from Oklahoma crude (Oil No. 6-R).

Note. Observations of cracked pressure tar residue will be made on Section 5-R.

Experiment With Different Grades of Oil

The term "grade" is used here in a different sense than "kind." Any of the kinds or types of oils mentioned in the preceding series of tests might come in a number of grades ranging from light, thin oil for cold application to very thick, heavy products for hot application. In this series of tests only those grades commonly employed on earth roads have been used.

EXPERIMENTAL STUDY OF OILED ROADS IN ILLINOIS—TYPICAL OILED ROAD AND THE OILING EQUIPMENT.

Section 5-C. ¾ gal. per sq. yd. in three applications of light oil showing 55% of solid residue of 100 penetration. Oil No. 6-C used.

Section 3-C. ¾ gal. per sq. yd. in three applications of extra heavy oil showing 72% solid residue of 100 penetration. Oil No. 7-C used.

Section 9-R. ¾ gal. per sq. yd. in three applications of medium grade oil showing 67% solid residue of 100 penetration. Oil No. 2-R used.

Note. Sections 5-C and 3-C are comparable with sections 11-C to 15-C, inclusive, and section 9-R is comparable with section 1-R and with sections 11-R to 14-R, inclusive.

Experiment With Priming Coat of Light Oil Followed by One Application of Heavier Oil

An initial application of light oil has been used in this series of tests followed by an application of heavier oil. The use of the coat of light oil is analogous to the use of the priming coat of thin paint which painters use on new wood surfaces. It is contended by some that the coat of light oil will give depth of penetration and serve to bond the wearing mat to the sub-grade, thus preventing scaling and loosening of the wearing surface which sometimes happens under the influence of frost action.

Section 4-C. One application amounting to ¼ gal. per sq. yd. of light oil followed as soon as absorption was complete by one application of heavier oil. Oil No. 6-C used for priming coat. Oil No. 2-C used for final application.

Section 8-R. One application of ¼ gal. per sq. yd. of E-2 grade oil followed by one application of E-3 grade oil. Oil No. 1-R used for priming coat. Oil No. 2-R used for final application.

Experiment With Varying Widths of Oiled Roadway

While an oiled strip 16 ft. or under is desirable even where traffic is light, many roads in Illinois are oiled in much narrower widths. The following sections have been oiled in less than standard widths to compare with the wider sections.

Section 1-C. Oiled by applying two 8-ft. strips down each side of the road and one 8-ft. strip down the center, thus making an oiled roadway 16 ft. wide with a single application on the outer 4 ft. at each side and two applications down the center. By this method of oiling a 16-ft. oiled roadway is obtained with the same quantity of oil that would be required for a 12-ft. road with two applications the entire width. Oil No. 3-C used.

Section 2-C. Oiled with two applications, 12 ft. wide. Oil No. 3-C used.

Section 10-R. Same treatment as section 2-C except oil No. 2-R used.

Maintenance

Section 15-R. This section shall receive no drag or other maintenance subsequent to oiling.

Section 16-R. This section is under intensive drag maintenance.

Different types of drags and maintainers will be tested out on other sections in an effort to arrive at the most efficient and economical method of maintaining an oiled road.

Traffic Tests

It is evident from ordinary observations that different kinds of traffic exert a markedly different effect on an oiled road. Narrow steel tires seem to cut up and rapidly destroy an oiled surface while on the other hand pneumatic tires exert an ironing effect which is highly beneficial if not essential to the formation of a satisfactory wearing surface. A limited number of traffic tests will be conducted in order that the effect of different kinds of traffic may be studied.

Soil and Drainage Conditions

The sites chosen for the experiments represent average Illinois conditions. At Cambridge the soil consists of brown silt loam with strips of black clay loam in the low places. The same general type of soil occurs at Rosemond but it is less dense and therefore not so gummy and sticky when wet and is more easily ground to dust in dry weather. Both roads are supposedly well drained and are free from deep cuts or excessive grades.

Grading and Preparation of Road for Oiling

Both roads are graded to a width of 24 ft. and carry an average crown of about 9 ins. The Rosemond Road has not previously been oiled but was graded as a state aid improvement in 1916. No grading was required on this road, it being only necessary to prepare the surface for oiling. The road was given careful drag maintenance for about a month before oiling and just prior to spreading the oil was given a final smoothing up, using a heavy, 3-way drag on some of the sections and a small, patrol grader on others. The soil on this road is inclined to be light and silty and easy to work. With very little work the surface was brought into perfect condition for oiling.

The Cambridge Road had been oiled the previous year but had broken up during the winter and spring so that little or no oil was in evidence at the time it was selected for the experiment. This road required considerable reshaping to put it in suitable condition for oiling. Grading was started May 18 and completed May 25, after which the road was kept carefully dragged until final preparation for oiling was begun. The finishing of the surface was accomplished with a 4-sectional blade maintainer with a mould-board drag attached behind. By means of the maintainer, a perfectly

TABLE I—ANALYSIS OF OILS.

Oil Number	Name of Oil	Specific Gravity at 25°C.	Engler Viscosity at 60°C.	Total Bitumen, per cent.	Bitumen insoluble in 86°Be. Naphtha per cent.	Fixed Carbon, per cent.	5 hour Evaporation Loss, per cent.	Flash Point, °C.	Solid Residue of 100 Penetration, per cent.	Ductility of Solid residue
1-C	*	0.939	21.4	99.7	1.4	2.9	....	210	67	1.5
2-C	**	1.041	18.7	99.8	12.4	9.1	....	183	68	100+
3-C	***	0.963	23.5	99.9	15.6	8.0	5.6	105	63	100+
4-C	****	0.948	17.1	99.3	5.6	4.1	....	195	69	2
5-C	*****	0.961	15.6	99.8	14.9	7.5	15.2	98	59	87
6-C	******	0.938	10.3	99.9	6.7	4.3	5.4	95	55	42
7-C	**	1.055	32.6	99.7	17.1	10.9	....	185	72	100+
8-C	******	0.953	21.6	99.8	9.6	6.0	....	133	63	36
1-R	**	1.031	11.3	99.9	12.5	8.7	....	185	63	100+
2-R	**	1.043	22.1	99.9	13.1	8.9	....	195	68	100+
3-R	*	0.938	13.7	99.9	2.9	2.9	....	190	56	11
4-R	******	0.947	10.6	99.9	5.6	4.3	4.5	115	55	21
5-R	*	0.943	13.6	99.9	8.6	5.1	....	129	58	41
6-R	****	0.945	10.3	99.5	6.1	4.0	....	155	62	2.5

* Mid-Continent skimmed oil.
** Cracked pressure tar residue.
*** Mexican asphaltic oil.
**** Mid-Continent cracked oil.
***** Cut-back asphaltic oil.
****** Mid-Continent-Mexican Blend.

smooth surface free from all waviness or unevenness was obtained. The drag served to crush up all traces of clods or sods deposited at the discharge end of the maintainer blade.

Application of Oil

The Cambridge Road was oiled between June 14 and June 20 and the Rosemond Road during the last three days of June. All oil was heated to a temperature between 150 and 160 deg F. before application. At Rosemond the oil was heated in the tank cars by conducting a jet of live steam directly into the oil through a ¾-in. pipe entering the car through the dome. Laboratory tests revealed that about 3% of water was introduced into the oil by this method of heating. About four hours were required to bring the oil to the required temperature. At Cambridge the oil was heated by means of a patented instantaneous steam heating device as the oil was pumped from the car to the distributor. Practically no water was introduced into the oil by this method of heating.

Pressure distributors of a late type, without heating attachments and equipped with pneumatic tires, were used on both roads. Those used at Cambridge had a capacity of only 460 gals. and were capable of attaining a high speed. This type of distributor has the advantage over the heavier types in that it does less damage to the prepared grade than heavier machines or machines equipped with solid tires. One of the machines used at Rosemond had a capacity of about 600 gals. and the other about 750 gals. The latter machine proved too heavy as it caused some deformations of the prepared road surface.

On both roads the distributors were carefully adjusted to spread at the rate of ¼ gal. per square yard. Each application was allowed to be completely absorbed before applying the succeeding coat. When more than ¼ gal. per yard was applied at one time, it was found that the oil tended to flow to the sides of the road before it was absorbed.

ANALYSIS OF SOME CENTRAL STATION HEATING PLANT PROBLEMS

At the Crookston Convention of the League of Minnesota Municipalities, in 1922, a resolution was passed requesting the analysis of some of the problems of Central Heating in the State of Minnesota. In accordance with this resolution the Executive Secretary, Mr. Morris B. Lambie, requested me early last fall to make a study of this new public utility.

Being an engineer, I was mainly interested in the engineering problems that are met with in this branch of heating but as I could readily see that the League was also interested in the legal problems that centered on Central Heating I made a study of them as they appear in the State of Minnesota.

Legal Aspects in Minnesota

Chapter 122 of the Laws of 1917 as amended by Chapter 108 of the Laws of 1921 gives all cities of the fourth class

(that is to say, cities with 10,000 inhabitants or less) and all villages with less than 10,000 inhabitants the power to own, operate, and acquire central station heating plants. At the present time such a power is denied the cities of the first, second, and third classes. Whether these large cities can experience this power without legislative authority is a question. According to a decision in a Montana court it can be acquired by implication. The learned judge expresses himself somewhat as follows: "A municipal corporation having express authority to operate an electric light and power plant may lawfully, as incident thereto, lay conduits to enable it to supply surplus steam from the plant to heat the houses of its inhabitants." (Milligan vs. Miles City, 51, Montana 374, 153 specific 276, L. A. R. 1916C 395.)

In case of home rule cities in the first, second, and third classes I am of the opinion that this may be done in Minnesota. It is a municipal power that has in some cases been delegated to municipal corporations in Minnesota and elsewhere, and as it is not against the general policy of the State and pertains to a municipal subject there is a possibility that the above mentioned muncipalities may own, operate, or acquire central station plants without special legislative action.

In the case of the other cities without home rule charters and in the first, second, and third classes, it is possible that they might try to own and operate municipal heating plants as a by-product of an electric plant on the basis of the Montana decision cited previously. Whether they would succeed in doing so is a question for the courts to decide. They could not, however, in my opinion, own and operate a plant whose primary purpose was heating, or whose primary purpose was heating with electricity as a by-product without first getting authority from the State legislature. This authority could be given by special statute drawn up for the purpose or by amending Section I of Chapter 452 of the Laws of 1907 so as to include heating plants within the definition of 'public utilities" as defined in that act. As far as I can see there is no good reason for denying this right to the larger municipalities and I suggest that the League, through its many friends in the legislature, take action and see that this power be given all Minnesota municipalities regardless of size or classification.

The engineering problems of central heating are the same in Minnesota as elsewhere and they simmer down to getting heat to the consumer and the condensation back to the power plant at as low a cost and in as efficient a manner as possible. But before presenting a series of facts or figures together with the engineering terms, I believe it wise to present a brief resume of the history and advantages of this utility and also impress you with the fact that none of the problems can be presented in great detail without becoming very monotonous and tiring.

Growth of Central Station Heating

The original district heating plant was installed by the late Birdsall Holly in the small city of Lockport, New York, in 1877, and supplied heat to approximately five stores, seven residences, and two churches, through about one mile of underground piping. Live steam was used and the water of condensation returned to the plant and re-evaporated. Approximately ten years later the first installation of a central station hot water heating plant was begun. Since that time the use of central station heating has become more and more extended until in 1917 there were approximately 401 central station heating plants in the United States that supplied heat on a commercial basis either as a municipally or privately owned plant. Of this total number 351 were steam plants, and 50 hot water. (These figures were obtained by Mr. H. C. Kimbrough, Western Manager for the American District Steam Company.)

The advantages of Central Station Heating are threefold: (1) The advantages to the consumer; (2) The advantages to the community in general; and (3) As a by-product to the plant to which it is connected.

Advantages to Consumer

The advantages to the consumer are: No coal in the basement with coal dust and ashes over the house; no ashes to be hauled; and no smoke to contaminate and stain the curtains and walls. There is always a constant even heat with plenty of hot water for domestic purposes. There are no fires to build and attend, and no worry about freezing of pipes when away from home. Insurance companies are just awakening to the fact that cheaper rates should be given a home supplied with central heating, and this item should not be over looked.

The expense of central heating to the consumer depends upon the individual. There is real opportunity for economy. By a proper use of heat when needed,

the invoice for heating should be a very little larger than for the individual plant. Some companies even claim a reduction in the cost. There is, however, a distinct saving in that there are no boiler repairs, no boiler investment, no ashes to be hauled away, and possibly lower insurance rates. In every case the installation of a central heating plant has increased the value of the consumer's property and in that manner lowered the expense.

The community is benefitted by the installation of central heating plants: (1) By the general increase in the value of the property, and (2) by the abatement of the smoke nuisance.

The Most Advantageous Application

As a by-product to an electric plant central heating finds its most advantageous application. It is a known fact that practically every steam operated power station is, from an economic standpoint, wasteful. A single expansion engine will not use more than about 7 percent of the heat supplied to it; a compounded engine about 11 to 13 percent; and a triple expansion engine about 18 to 20 percent. Hence 80 to 93 percent of the original heat is available for other purposes, and much of this heat can be reclaimed from the exhaust steam by using the latter for heating purposes. When this is done the engines must be run non-condensing and carry sufficient back pressure to cause the steam to circulate.

Contract Provisions

To connect a consumer to a central heating plant is not as easy a matter nor as inexpensive a matter as it may appear. The cost varies depending upon the type of plant used prior to the time of connection and directly as to the distance of the installation from the mains. As a rule the contracts contain provisions somewhat as follows:

"The company agrees to install service pipes for the above named premises to the property line free of charge. From said line, the Company will install the service pipes at the following rates . . . ."

"The consumer agrees to make all necessary changes and additions to his present heating pipes and apparatus on above said premises, that the rules and regulations of the Company may require in order to insure a satisfactory service to the consumer. If at the present time there are no heating pipe and apparatus, but the consumer contemplates installing the same, no service connection shall be made to the consumer's premises until such new installation of heating pipes and apparatus has been approved by the Company."

"It is further agreed that the service pipe and extensions thereof, meter, meter connections, valves, or any other connections installed on the consumer's premises by or at the expense of the Company shall remain the property of the Company and subject to removal by, and only by, said Company.

As practically every Central Heating Plant installation uses either steam or water as heating medium it follows that many individual plants are unsuited for connections.

Premises heated by stoves or hot air furnaces must have new heating apparatus installed. Where hot water radiators are installed, steam or hot water may be used. Where steam radiators are installed only some form of steam will prove satisfactory. It follows from the above that as a rule, a steam installation of some form is the more flexible type of central heating plant to erect. However, as both plants are in use a discussion of the various characteristics will be given to amplify the preceding statement.

There are two types of hot water systems used—the one and the two pipe system. In the first case suitable shunts must be provided so as to allow for proper circulation. The two pipe system operates similarly to the ordinary hot water installation except on a larger scale. The two pipe system is the more common method of design. To maintain a vigorous circulation in either system centrifugal pumps are connected to the return side of the system.

Advantages of Hot Water System

(1) Line losses from heating mains are less than in a steam system. The average temperature of a hot water main is about 160 deg. F. compared to the steam main at 212 deg. F. or more.

(2) Hot water mains are readily adapted to undulating ground conditions. If the service connections are taken off at the high points to relieve the air the mains may follow the contour of the ground. This is not true in the case of a steam installation. Here the steam and return lines must be carefully graded so as to eliminate pockets, and if relayed at any point drips with the attending trap and seal connection must be provided.

(3) The heat supplied is easily controlled by regulation of the hot water temperature according to the variation of the outside temperature. Tables have been prepared giving the variations. The

ordinary rule on which these tables are based is to have the temperature of the circulating water at about 160 deg. F. when the outside temperature is 30 deg. For each degree rise in the outside temperature the circulating water temperature is lowered 1 deg. Some tables take into account the wind velocity.

(4) Either exhaust steam from the engine and pumps, or live steam from the boilers may be used to heat the circulating water. The heating of the water is accomplished by passing it into tubular closed water heaters, or "comminglers" of the injector type, or by passing it through water-heating boilers.

(5) Gives a more pleasant and agreeable heating.

(6) Possible to run engines either condensing or non-condensing.

Advantages of Steam

(1) Generally cheaper to install. Does not require as large a pipe as the water system.

(2) Can be used for long distance distribution.

(3) Can be forced to carry overloads to a far greater degree than a hot water system.

(4) Operates satisfactorily on either steam or water radiation.

(5) Within practical limits, this system is not subject to pressure limitations.

(6) Easy to meter.

In designing a steam plant the engineer has wonderful opportunities for originability and ingenuity in working out his piping and distribution. He may use high pressure or low pressure in his mains, or a combination of both. He may have points of distribution to which he runs mains of high pressure and from which he runs mains of low pressure, or he may branch off from the main directly to the consumer's premises using a reducing valve to obtain a pressure of 1 to 2 lbs.

The design depends upon the locality, the topography, the cost of good water and its supply, and the cost of labor and materials. In any event, the engineer should always bear in mind that the economies and profits vary inversely as the mile of pipe in the distributing system.

A layman reading about the many advantages of central heating will think to himself, "Now why hasn't my town such a plant? We are just as large as the town of X and they have a plant." Then he reads in the newspaper of this heating plant being a failure and this one a success. Both plants are about the same size located in towns of almost the same characteristics. Then he wonders what determines the success of a district heating plant.

Factors Affecting Success

I will try to answer this question to the best of my ability, but the conditions are so complex and so varied and so subject to local conditions that I appreciate that the explanation offered cannot cover all situations. In order to grasp the points more easily they are presented in an outline form and then expounded in a more detailed manner.

(1) Sufficient demand for heat:

(a) Size of town; (b) Number and nature of industries; (c) Number and nature of institutions; (d) Number and nature of mercantile establishments; (e) Number of homes; (f) Characteristics of inhabitants; (g) Competing district heating plants; (h) Character of service and price charged; (j) Climate.

(2) Density of population and industries.

(3) Location of plant relative to the district to be heated.

(4) Location of plant relative to the water and coal supply.

(5) The variability of the engine load.

(6) Design and equipment of the plant.

Sufficient Demand for Heat

The size of the town; number and nature of industries; institutions, and mercantile establishments; and the number of homes are indicative of the possible heat load, while the characteristics of the inhabitants, the competition of other district heating plants, the type of service rendered and price charged, and the climate, will prove to be indicative of the demand for heat. Many a district heating plant promoter has learned this to his sorrow. The heat load was available but the orders connecting the same to the system were woefully lacking.

Knowledge of the type and characteristics of the inhabitants is essential to a promoter. Some classes of people are not financially able to pay for the advantages that district heating offers. They will cling to the old method of heating by stoves, or hot air furnaces, because that is the more economical. Religious, racial, and political friction between various functions may spell the down-fall or success of a plant. This is especially true in the smaller towns.

If the inhabitants have the ability to pay for the advantages of district heating, the character of the service rendered, and the rates charged will be controlling fac-

tors in their decision in the question of whether or not to install the same.

The combination of heat, light, and power supplied from a single plant tends to increase the economical operation by increasing the local factor. The labor cost in such a combination is not materially larger than for a single plant and competition is unwarranted, except in case of gross mismanagement which is productive of faulty service and high rates.

Figures have been produced tending to show that district heating is cheaper to the consumer financially than the small individual plant. Such cases are exceptions, however, and the service rendered must be of such nature as to warrant the expenditure of the additional money.

Density of Population and Industries

This is the basic criterion of whether a district heating plant should be installed. If the density of population is small the heat losses during transmission will be large, and likewise the fixed charges. The heat losses vary directly as the miles of pipes.

Location of Plant Relative to the District to Be Heated

There are two distinct items to have in mind when locating a plant in reference to the district to be heated: (1) line losses, (2) pressure to be carried.

As noted before, the line losses increase directly as the miles of pipe and, hence, it is desirable to locate the plant as close to the center of the heating load as possible.

The use of exhaust steam necessitates short distance service so as not to put much back pressure on the engines.

Location of Plant Relative to Water and Coal Supply

The points to be considered under water supply are four in number: Quality, Availability, Purity, and Hardness.

There should be a certainty of water supply because in a district heating plant the water loss may be great. Often the condensation is emptied into the sewer to avoid mechanical difficulties and excessive original cost arising in trying to return the same to the heating plant. Elevators, laundries, etc., also take a large consumption which cannot be returned to the plant.

The availability of the supply is usually easily solved and only in extreme cases viaducts may have to be constructed, but this is exceptional. The purity and hardness of the water are closely related. Alkalinity or acidity may produce excessive corrosion in the pipes, while hardness produces thick incrustations on the boiler tubes, reducing greatly the efficiency and increasing the maintenance cost. The hardness of the water may be removed by water softening processes.

Storage and railroad facilities are the two important items in connection with the coal supply. There must be a possibility for at least 30 days supply of coal. Where the comfort of several hundred people is in question, the district heating plant manager must not take any risk of a shut-down because of the lack of fuel. Even with a 30 day's supply on hand, there will be times when strikes or storms will cause the supply to dwindle to a dangerously small amount.

The plant should be located close to the main railroad line so as to reduce the initial cost and also to take advantage of the smaller amount of track to be kept open during the winter blizzards.

The Variability of the Engine Load

The ideal situation would be to have the load large enough so that each piece of apparatus using steam would be operating at full load most of the time. This will produce larger profits because as a rule exhaust steam will give a larger profit than live steam.

Design and Equipment of the Plant

In this connection the word "Plant" is used in its broadest meaning, including not only the boilers and their auxiliary equipment but also the mains, fittings, valves, conduit, and covering.

In laying underground conduit the materials and workmanship must be of the best. Inspection is difficult and repairs expensive.

The piping is usually carried in tunnels or conduits placed preferably below the frost lines. Conduits are cheaper and this is the common method employed. These vary in cost, form, and construction. Wood boxes, wood stave casing, concrete casing, and split tile are extensively used.

The tile must be laid in a trench that is properly drained. In sandy soil this is easily done but in clayey soil the tile must be laid on a cushion of crushed stone or rock.

The pipe covering must be of some efficient material. Wool felt, asbestos, mineral wool, kieselguhr, and magnesia are the most common materials used. The fittings as well as the pipe should be well covered. The thickness will depend upon the plant lay-out and simply becomes a matter of calculating the benefits derived against the cost of the installation.

In selecting a pipe covering not only

the insulating properties and the cost of covering should be considered, but also several physical characteristics.

The covering should be easy to apply and should be of a material whose tenacity of structure will prevent easy breakage and whose chemical composition is such, that in case of becoming wet it will regain its insulating properties when dried out.

To operate a central heating plant successfully accurate records of cost and performance are necessary, and to accomplish this purpose a complete set of steam, water, and draft gauges, and meters is essential. In selecting the meters to measure the condensate at each service connection special care should be exercised. Accuracy, ease of installation and reading, compactness, absence of wearable parts, lightness, and cost should all come into consideration when selecting these meters.

Data on iMnnesota Plants

At the present time there are approximately 30 central heating plants, omitting all institutional central heating plants such as the one at the University of Minnesota, in Minnesota, having a connected amount of radiation of about 2,500,00 sq. ft. Of this number there is only one plant that uses water as a circulating medium entirely, and one plant that uses both water and steam, while the rest use steam entirely. Some idea of the adaptability of central station heating may be gained when it is noticed that the connected amount of radiation varies from 2,600 sq. ft. at one plant to approximately 800,000 sq. ft. at another.

One characteristic of central station heating in Minnesota is noted in that there are only seven privately owned plants—the rest being municipally owned.

Of the total number of stations over one-half use the vacuum system of heating, either entirely, or in connection with some other method, and only three plants do not use exhaust steam as a portion of their source. The pressure carried in the heating mains varies from 10 in. vacuum to 150 lbs. pressure. The most common pressure in the mains is approximately from 3 to 5 lbs. The pressure in the services from 10-in. vacuum to about 8 lbs. pressure.

In regard to the cost of installing central heating. It is here that an official will make a greivous error if he is not careful. He will be told that this town had its installation completed at a cost of $9 per running foot of main and cannot understand why the installation in his town should be $11 per running foot under what appears to be practically the same conditions. The towns are the same size; the connected load almost equal to the square foot of radiation; the industrial and retail districts similar; and yet this central heating company wants about $2 more per running foot of main than in the town of X.

What this official does not know is that the soil in his town is clayey, necessitating more feet of drains than in the town of X where the soil is sandy; that due to crowded conditions in his streets by gas, water, and sewer mains, expensive offsets were necessary at practically every corner; that expansion joints or variators were placed slightly closer together; that additional one quarter inch thickness of pipe covering had been installed; and that the pipe sizes were large enough to take care of a normal expansion of services for several years to come. As time goes by this official will realize that perhaps the additional cost was justified when he sees what is happening to his neighboring town. Additional services have made the mains too small and they are being dug up and replaced and this costs money.

Competition will usually see that the minimum sizes of pipes and the smallest wall of pipe covering are used but it is up to the officials to see by careful attention to engineers' opinions that the installation is properly designed.

Central heating companies are as a rule as vitally interested as the public in the success of a plant. It means more business for them. Do not subject their corps of expert engineers to such cutthroat competition that the only recourse that they have left is to design a system that is large enough today and too small tomorrow. Conditions vary greatly in every municipality and comparison should not be by a layman who cannot see exactly why one installation costs more than another. He should bear in mind that every condition that I mentioned as affecting the location of the plant will also affect the cost of the plant and he should also remember that operating costs are as big an item as the original cost.

In conclusion I have one or two recommendations to make to the League. The first is to prepare a model franchise for use in central station heating provided you have not already done so. Second, to make a detailed study of the comparative advantages of hot water and

steam heating mediums. Third, to make a study of the best method of financing the installation of municipally owned central station heating plants and the rates to be charged.

The foregoing is an address by Mr. Lund before the Annual Convention of the League of Minnesota Municipalities at Faribault, June 21, 1923.

ORNAMENTAL MEMORIAL HIGHWAY BRIDGE OVER WISCONSIN RIVER AT SAUK CITY, WIS.

By W. C. Buetow, Bridge Engineer, Wisconsin Highway Commission, Capitol Annex, Madison, Wis.

The completion of the Wisconsin River bridge at Sauk City, established a new precedent in bridge ornamentation for Wisconsin. This was due to the generosity of two citizens of Milwaukee, Wisconsin; namely, Ex-Governor Emanuel Phillip and Architect A. C. Clas. These two distinguished men who were reared in Sauk City make it possible for that city to have the beautiful approach. Ex-Governor Phillip paid for memorial approach and Mr. Clas designed and supervised the installation. The approach is shown herewith.

Sauk City lies 25 miles northwest of Madison on State Trunk Highway 12, which is the most direct route from Chicago to the Twin Cities. It passes through the famous Lake Geneva district, Madison, the capital city of Wisconsin and touches the Dells of the Wisconsin River at Kilbourn. Between here and the Twin Cities the road passes through many points of interest.

Wisconsin Special Bridge Act

The state legislature in 1919 and 1921 enacted a special bridge act for the purpose of enabling communities to construct large bridges. Structures like the Sauk City bridge would be too big a burden for rural districts if it were not for the special state aid. The 1923 legislature increased the appropriation from $100,000 annually to $125,000 for 1924, $150,000 for 1925 and thereafter $175,000.

Briefly, the following are the general provisions: Any city, village or town bordering upon or through which any navigable or meandered stream runs is authorized or empowered to build a large bridge either alone or jointly. To be eligible, the bridge must be 450 ft. in length exclusive of the approaches. When formal application has been made for aid the State Highway Commission must hold a hearing and submit its findings. They have the power to decide the necessity for a bridge, the location and the type of structure. If deemed necessary the commission notifies the units of government involved of the amount of money they must raise. The city, village or town must then raise one-third the cost and it is obligatory on the county to provide its one-third, and the state the balance. The entire work is under the supervision of the Wisconsin Highway Commission.

Bridges of 300 ft. or more in length lying on the State Trunk Highway or on a road or street in a city of the fourth class forming a direct connection of the State Trunk Highway system is eligible to state aid. Under this provision the state pays 50% and the county 50%. They, however, have a right to assess the city or town which is directly benefited not more than 40% of the county's share. This work is also under the direct supervision of the Highway Commission.

In order that backward communities cannot hold up important links in the State Trunk Highway system the Commission may institute proceedings and build structures under the preceding provisions.

VIEW OF SAUK CITY, WIS., MEMORIAL BRIDGE OVER THE WISCONSIN RIVER.

VIEW OF WEST APPROACH OF SAUK CITY, WIS., MEMORIAL BRIDGE.

The Sauk City bridge work was let on Oct. 7, 1921, and opened to traffic on Sept. 29, 1922. Very good progress was made on the substructure during the winter months. Weather and water conditions were very favorable.

Work started on Nov. 1, 1921. A large stiff leg derrick was placed at the east abutment excavating and driving piles. A similar derrick but smaller was started at the same time from the west bank driving falsework trestle. On December 12th the trestle was completed and the east abutment foundation ready, for pouring. Concrete was placed on December 16th. Due to bad weather and the holidays the abutment was not finished until Jan. 10, 1922. From this date to March 13th eleven piers were comp'eted, containing 2,093 cu. yds. of concrete and 10,000 lin. ft. of piling.

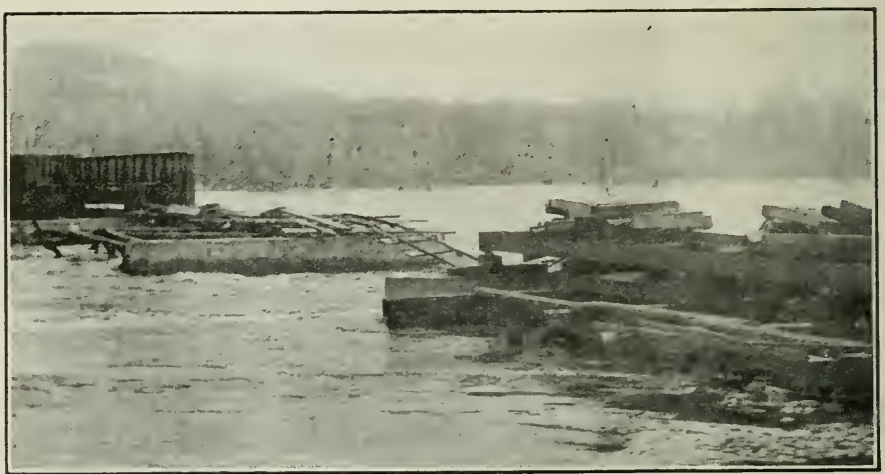
Construction Difficulties

On the 10th of March the river started to rise and by the 14th all work on the foundation stopped until the 29th of May. An accompanying view shows the high water stage. Normal water is approximately 12 ft. below that shown in the pictures.

Some steel stringers, industrial track and two spans of falsework were lost. During the high water the river bottom was washed from beneath some of the piers for a depth of 8 ft. The entire load was carried on the 30 ft. piling. As the water receded the sand filled in under the piers. All piers have been rip-rapped up to normal water elevation. No doubt this will be lowered somewhat next spring during high water.

Cold Weather Concreting

All concrete in pier footing was placed by a tremie. Steam was run in the water in the cofferdam for 24 hours before any concrete was deposited. After the footing was poured the pier was completely housed in with canvass. Forms were then built and steam coils placed outside the neat work from just above the footings. The aggregates and mixing water were heated. During the placing of con-



HIGH WATER STAGE DURING CONSTRUCTION OF SAUK CITY, WIS., BRIDGE. SOME STEEL STRINGERS, INDUSTRIAL TRACK AND TWO SPANS OF FALSEWORK WERE LOST.

crete for three days after completion steam was kept up.

The contractor produced his coarse aggregate from a gravel pit on the east bank of the river. Good sand was found in a bar. The mixer was located on the east bank and the concrete was transported by industrial railway. The concrete for the floor and sidewalk was made from shipped-in aggregates.

Quantities

The structure consists of ten 84-ft. plate girder spans, an 80-ft. Schurzer Rolling lift and its 70-ft. approach girder. There is a 6-ft. sidewalk on the down stream side and the structure has a 19-ft. clear roadway between curbs.

Three thousand cubic yards of concrete were poured, 13,270 lin ft. of piling driven and 1,281,120 lbs. of steel placed. The substructure is protected by 2,200 cu. yds. of rip-rap.

Considerable grading was required in the east approach which was on a new location; 27,000 cu. yds. of fill was placed and 5,512 sq. yds, of one coarse concrete paving laid.

Cost

The structure proper, including $1,500 for wiring and lighting fixtures cost $148,531.76. The approach cost, exclusive of the memorial work, was $31,050 55, or making a total expenditure of $179,582 21. Right-of-way on the two approaches, engineering and supervision brought the total to approximately $190,000.

THE O'SHAUGHNESSY DAM AND ITS DEDICATION

(Editor's Note: It is often said that the work of the engineer is not understood and appreciated by the public. Generally speaking, this is true. A few monumental structures bear the names of their builders and that is the case with the O'Shaughnessy Dam of the great Hetch Hetchy project in California. The present article describes the dam and its construction in detail and also tells of its formal dedication. It is a distinct pleasure to record here this evidence of popular and official appreciation of the work of one great engineer. The matter here presented is all taken from the July 19, 1923, number of the Municipal Record, the official journal of the City and County of San Francisco, which was entirely devoted to this subject.)

Naming the Dam

Resolution No. 20950, adopted unanimously by the Board of Supervisors on March 26, 1923, by the Board of Supervisors of the City and County of San Francisco, naming the dam, reads as follows:

"Whereas, the dam at the outlet of Hetch Hetchy Valley has been completed, which will convert this valley into a mammoth reservoir, impounding for the use and benefit of future generations billions of gallons of water that heretofore have gone wastefully to the sea; and

"Whereas, the dam is one of the largest structures of its kind in the world and long will endure as evidence of the knowledge and genius of its creator, the Honorable M. M. O'Shaughnessy, City Engineer of the City and County of San Francisco; therefore,

"Resolved, That as a monument of the great ability displayed in its creation, and to perpetuate in the years to come the name of its builder, said structure shall be designated and hereafter be known as 'O'Shaughnessy Dam,'; also

"Resolved, That the Board of Public Works be directed to have the aforesaid name suitably engraved upon the structure."

The Dedication

Terminating the labors of 8 years, interrupted by the World War, the O'Shaughnessy Dam, named in honor of its builder, City Engineer M. M. O'Shaughnessy of San Francisco, was dedicated by Mayor James Rolph, Jr., and a group of distinguished citizens gathered at the dam site, on July 7, 1923.

The dedication of O'Shaughnessy Dam marked an epoch in the history of San Francisco. The dam, 341 ft. from foundation to crest, is the first large unit of the entire Hetch Hetchy project to reach completion and it will form the keystone of the stupendous project which will eventually supply San Francisco with water and power sufficient to care for millions. The O'Shaughnessy Dam is one of the largest dam structures in the world and the reservoir it forms is the largest reservoir west of Chicago.

Several Hundred Present

Several hundred citizens, coming from San Francisco aboard a special train and entering the Hetch Hetchy district from Yosemite Valley, participated in the dedication. Heading the San Francisco delegation was Mayor James Rolph, Jr., with City Engineer O'Shaughnessy, while the

Yosemite Valley visitors were led by Former Mayor and Senator James D. Phelan. Representatives of the Turlock-Modesto Irrigation District were also present to participate in the dedicatory exercises.

The keynote of the addresses made by the various speakers was the tribute paid to Engineer M. M. O'Shaughnessy in constructing the dam. Tribute was also given the memory of the late Dr. Edward Robeson Taylor, former mayor of San Francisco.

The program of dedication included the official turning over of the dam to the City and County of San Francisco by the Utah Construction Company, contractors. This company constructed the dam under the direction of Chief Engineer O'Shaughnessy.

The cost of the dam is placed at $6,647,356.34 and required an actual working time of 3½ years, much difficulty being encountered in finding suitable foundation for the structure. The reservoir that it forms is 7½ miles long and in some places ½ mile wide, covering 1,500 acres. The reservoir has a storage capacity of 66 billion gallons, draining a watershed of more than 300,000 acres.

From the bottom of the foundation to the crest of the dam is 341 ft., while the length of the crest is 600 ft. The initial crest elevation is 3,726 ft.

From this huge reservoir, San Francisco will get its future water supply and eventually develop sufficient electrical energy to furnish the city's industries with hydro-electric power.

The Contractor Remèmbered, Too

On the afternoon of July 7 the group of citizens who made the trip to the dam site aboard a special train from San Francisco, and others who came into the Hetch Hetchy district from Yosemite Valley, assembled before the cottage of Chief O'Shaughnessy. Here, seated in the shade of the trees clustered about the cottage, they listened to addresses which marked a huge step forward in the development of San Francisco. On the bluff above the dam within stone's throw of the structure, tribute was paid to Engineer O'Shaughnessy and the corps of men who made the dam possible.

Promptly at 2:30 o'clock, W. H. Wattis, president of the Utah Construction Company, officially delivered the dam to San Francisco. Wattis recalled the history of the work done on the project and complimented San Francisco on having stuck to the task of its construction.

Congratulations were extended the company by President Timothy A. Reardon of the Board of Public Works, who accepted the dam in the name of the City and County of San Francisco. The work on the dam was under the supervision of the Board of Public Works.

Mayor Rolph's Address

Following the address of Reardon, Mayor James Rolph, Jr., introduced by Chairman J. Emmet Hayden, Supervisor, gave a vivid address, in which he praised the efforts and achievements of Engineer O'Shaughnessy.

The Mayor spoke, in part, as follows:

"The people of San Francisco pay tribute of admiration and respect to M. M. O'Shaughnessy, City Engineer, as we dedicate O'Shaughnessy Dam—the master work of a great career, destined to stand throughout the centuries as one of the mightiest structures built by man. A great knowledge and a wide experience, the genius to create, an inspired vision of the California of the future, and a courage undaunted by the sheer magnitude of the undertaking, have enabled Chief O'Shaughnessy to carry on this public enterprise, fraught with beneficence for the people of our own City and of our broad coastal empire.

"Our Chief Engineer is more than a scientist and a builder. He has the lovable qualities of kindness and unselfishness. He is one of the great souls of our generation. O'Shaughnessy Dam is a monument to his genius. It serves its useful purpose now and will endure for all time. But we who know the builder think both of the work and the man, and while we dedicate the one we salute the other, offering our gratitude and affectionate regard.

"It became my task on assuming the office of Mayor to find a man who could do the job and that man was Michael Maurice O'Shaughnessy. His name will live as long as time, for this great dam is built to stand for 2,000 years or more.

"I am going to read a telegram which I received this morning from a San Franciscan who offers what I consider a splendid suggestion:

"'As a testimonial to the genius and self-sacrifice of M. M. O'Shaughnessy, I offer the suggestion that a fund of $100,000 or more be gathered by popular subscription and presented to him as a

testimonial of appreciation from a grateful people.

(Signed) HARTLAND LAW.'"

The telegram was received with applause and cheers.

"A lot of men spend all their time in the acquirement of riches and affluence, but these riches and affluence leave no monument to the individual. Here is a man, Michael M. O'Shaughnessy, who had no thought of riches and affluence. He has dedicated his life and his work to the community which he loved. When the men who have spent their time acquiring riches have gone on, they leave no monument to their memory, but when M. M. O'Shaughnessy passes to his eternal reward, this monument shall stand to his memory for 2,000 years to come. Many generations shall look upon it and bless this man who gave his genius and life to our City."

Mayor Rolph closed with a tribute to Former Mayor and Senator James D. Phelan, referring to Phelan as the "Father of Hetch Hetchy."

Ex-Senator Phelan's Address

In an address following Mayor Rolph, ex-Senator Phelan reviewed the history of the Hetch Hetchy project from its inception. Ex-Senator Phelan's address, in part, was as follows:

"I have been spending a few weeks in the high Sierra region and, on account of my early association with this work, I could not resist coming here today. Mayor Rolph has generously, in his speech, called me the 'Father of Hetch Hetchy.' I came to the mountains seeking a renewal of youth, and lo! I have been placed in the category of ancestors. But I desire to share the honors of paternity with others better deserving. Under the new charter the city government was directed in 1900 to investigate the sources of and provide for the City and County a municipal water supply, and, with that purpose in view, when elected Mayor, I appointed eminent civil engineers to compose the Board of Public Works. They were Col. George H. Mendell, U. S. A., retired; Marsden Manson and Jeremiah Mohony, contractor and builder, who, in turn, appointed C. E. Grunsky City Engineer. These men knew, after investigation, that there was one site in the mountains to be preferred above all others, available and adequate for municipal water supply purposes, and that was Hetch Hetchy Valley and Lake Eleanor. They jealously guarded their information, which they brought to me and, on their advice, I secretly filed upon the lands in my own name, subsequently turning my rights over to the City. Secrecy was desirable to avoid the interference of rival claimants, speculative locators and cormorant corporations, and I acted as an individual under legal advice because there was a question as to the right of a municipality, as such, to make a filing under the statute.

Fought by Nature Lovers

"Application was then made to the Interior Department for a reservoir right of way, and the long fight was thus inaugurated. The 'nature lovers,' well organized, denounced the proponents of this plan as vandals, and the City of San Francisco as a purblind Philistine seeking to destroy the beauties of nature. It is safe to say that every paper in the United States was in opposition, and every selfish interest, which deprecates public ownership, was arrayed against the City. Secretary of the Interior E. A. Hitchcock, in the Roosevelt Cabinet, decided that the Department had no jurisdiction. On review he reaffirmed his decision; and here I desire to pay a tribute to the well-beloved Theodore Roosevelt, who was our steadfast friend from the beginning. No man loved nature more ardently, but no unbalanced sentimentalist could turn him from his desire to confer a benefit upon a million human beings living by the principal port of the United States on the Pacific, and free them from corporation dictation; while, at the same time, by the conversion of a meadow into a lake, enhance the scenic values of the Sierras.

"In this crisis Theodore Roosevelt referred the legal question to another member of his Cabinet, because, as the President said, 'He is a Californian,' and nothing discouraged by his concurrence in the opinion of Secretary Hitchcock, admitted that he had made a serious error by not, as a matter of course, referring it to his Attorney-General. The Attorney-General decided that the Department of the Interior had jurisdiction, and Theodore Roosevelt rejoiced with the people of San Francisco, who were granted the rights petitioned for by Secretary Hitchcock's successor, James A. Garfield.

Flays "Willful Betrayal"

"Then President Taft's administration followed, and the notorious Secretary of the Interior, Ballinger, was installed in office and, although he had promised me,

on the presentation of a letter of introduction from the retiring President, that he would not disturb any act of his predecessor, he soon gave notice to the City to show cause why the rights should not be revoked. He was presently relieved from office, and; just at the close of the Taft administration, Secretary Walter Fisher heard the City's case, and he recommended that application be made to Congress. The tide of opposition was growing. Robert Underwood Johnson, editor of the Century Magazine, led the fray until, during the hearing before Fisher, after having pronounced a eulogy on the beauty of Hetch Hetchy Valley, he was forced to admit on the stand that he had never seen it. The corrupt city government then delivered a body blow by declaring, through its Board of Supervisors, that the Hetch Hetchy was an inferior site and that they formally abandoned it in favor of the Blue Lakes, which somebody had for sale. The Hammond and Hammond Hall interests filed rights for which the City was obliged to pay a million dollars, as a price of recovery of its own property, lost by willful betrayal.

"The Woodrow Wilson administration succeeded, with Franklin K. Lane as Secretary of the Interior, who, however, was disqualified from acting because he had been San Francisco's City Attorney. But his services were invaluable in advising Congress, and, after several years of persistent campaigning, both Houses finally voted the Raker and Pittman bill giving the City all she claimed as necessary for the development of water and hydro-electric energy. Delegations headed by Mayor Rolph, consisting of Chief O'Shaughnessy, City Attorney Long, Clerk of the Board of Supervisors John S. Dunnigan, Raymond Baker and many others, managed, one way or another, to interview separately each member of both Houses, to impart information and to promote the measure. After holding the bill nearly ten days, President Wilson affixed his signature, and George Harvey, who liked him not, declared in the North American Review that it was a most courageous act, for which he gave due praise to the President because, said Harvey, it was opposed by the entire press of the United States. But Harvey also said that so great was the opposition that he made a personal investigation, and declared that the President could not have justly done anything else.

Ends Long Conflict

"Now, after 22 years of conflict and construction, the O'Shaughnessy Dam, holding back the waters tributary to Hetch Hetchy, is an established fact. It is the work of a great engineer, and no scandal has tarnished the enterprise. It has, indeed, made the mountains more beautiful and its foes are now friends."

Chairman Hayden then called upon Engineer O'Shaughnessy to respond to the oratorical tributes paid him by the previous speakers. After opening his address, Engineer O'Shaughnessy called forward those men who had assisted him in the work of directing the dam construction.

Engineer O'Shaughnessy's address, in which he reviewed the work completed and the obstacles overcome, was as follows:

O'Shaughnessy's Speech

"We are all glad to be here today to participate in the pleasure of dedicating this great structure, which is 341 ft. in height from the bottom of the foundation to the present crest. One hundred and fourteen feet of the foundation work is submerged at the present time with water on the downstream side.

"To accomplish this work it was necessary to build four auxiliary dams, one on the upstream side to divert the main river into the tunnel; one on the downstream side 1,000 ft. below to stop flood water from backing into the excavation, and as the excavation progressed it was necessary to build two auxiliary slender dams, one immediately above the excavation and one below, before the pouring of concrete was undertaken in the main foundation.

"Peaks of floods in these high mountain regions come every year from melting snows on the 10th of June. At no time did the floods damage the foundations. They did, however, interfere with contractors' operations in bringing sand and materials from three miles up the valley.

"A camp to house 250 men was on the floor of the valley half a mile above the dam, as well as the remains of the existing camp which you see. As many as 500 men were employed on the project at one time, and a great many lives were lost through accidents incidental to this dangerous work.

Data on the Dam

The whole floor of the valley was entirely cleared of timber in two operations,

the first in 1915, when all the lower portion of the valley was cleared of timber, and the second in 1921-22, when the remainder of the reservoir basin was cleared.

"The present dam, built in the shape of an arch, with a 700-ft. radius, at the bottom of the foundation is at elevation 3,386. The bottom valve elevation is 3,508; initial crest elevation, 3,726; length of crest, 600 ft.; storage capacity, 66 billion gallons; drainage area, 294,000 acres; reservoir area, 1,500 acres; total concrete volume, 398,967 cu. yds.; excavation, 207,992 cu. yds.

The material from the excavation was hauled by train and deposited for a half mile up the valley. The weight of metal work in the valve system is 2,155,507 lbs., or over 1,000 tons.

"The entire contract estimate of the Utah Construction Company is $6,114,-648.86. The contract price for valves made in San Francisco, Philadelphia and Boston is $532,707.48, which makes a total of $6,647,356.34.

Comparison Shows Advantages

"The Ashokan reservoir of the City of New York, practically double the capacity of the Hetch Hetchy, has cost $32,000,000, which, reduced proportionately, would make a cost of $16,000,000 for the same volume as Hetch Hetchy. The Ashokan, however, is low level, with no power potentialities, so it is my thought that Hetch Hetchy will be very much appreciated by our future inhabitants of San Francisco, who have been struggling for 50 years to obtain a municipal water supply.

"An estimate was made of $4,500,000 for the completion of this project in 1910. Those of you who are familiar with the construction business are aware that the dollar of today will buy as much as the 50 cents of 1910. Common labor has increased in price from $2.50 per day up to $4.50 per day. Other labor has risen in similar proportion. Materials have also advanced. Cement, steel and all other materials have advanced at least 50 per cent beyond the 1910 prices. The powder which I purchased before 1910 for about 6 cts. a pound is now very nearly 20 cts. a pound. Hence, no explanation or apology is offered for the fact that as much cannot be completed now with the same money as in the period of 1910, when this hasty estimate was made.

"Another feature must be borne in mind that the project has been advanced from the 60 million to 150 million gals. a day water supply project to one of 400 million gals. per day, and all our plans have been laid to carry through the project of greater magnitude.

West's Largest Reservoir

"The construction of a dam of this magnitude and the occupation of this valley for a reservoir were forced on the City of San Francisco by interests antagonistic to human welfare. Practically $300,000 was spent between 1910 and 1912 preparing engineering reports on all streams in California from Mount Shasta to Merced to defend the City's rights, which were about to be abrogated to the use of this valley. The bill has been high but the prize is worth the cost. San Francisco has today the largest reservoir of any city west of Chicago. More water is held in this one reservoir than in the combined reservoirs of Los Angeles and San Diego. The work has been honestly done by the Utah Construction Company.

"I feel extremely flattered by the very touching remarks made by Mayor Rolph in relating my association with this work. It would not be fair, however, without distributing the credit for the successful completion of this project to the different other men and assistants who have been associated with its success. With your permission I will introduce Mr. W. H. Wattis, managing director of the Utah Construction Company; Mr. Hank Lawlor, superintendent of the Utah Construction Company, and Mr. A. E. Paddock, the active superintendent and engineer in charge of construction. The City's forces have been ably represented by Mr. L. T. McAfee, who supervised the excavation from 1919 to 1920. He also had charge of the construction of the Twin Peaks tunnel and Stockton Street tunnel in San Francisco. Mr. C. R. Rankin, who was resident engineer during the pouring of all the concrete and the placing of the gate valves, is the senior engineer and employe on the Hetch Hetchy project, having been with us since April, 1914, when the first survey was made into the dam-site, and is now going to have charge of the construction of the pipe from Irvington across the Bay at Dumbarton to Pulgas tunnel.

"Mr. Nelson A. Eckart, my principal assistant, who was in active charge of all the Hetch Hetchy project from the mountains to the sea and whose previous experience in completing the Municipal Railways in San Francisco is known to you all. The design for the structure of the dam is due to Mr. R. P. McIntosh,

who is the principal designing engineer on the Hetch Hetchy project and who has been associated with me for over twelve years in engineering work. Mr. R. J. Wood has been associated with Mr. McIntosh in the design of all the engineering plans and to Messrs. McIntosh and Wood I feel very much indebted.

Will Carry On Work

"The foundation has been put in by this generation, which will enable the dam to be carried in the future to a height 85 ft. greater, and which will increase its storage capacity about 50 per cent. This acts as a declaration of a definite policy on the part of the City of San Francisco to carry on and build in the future at a later date a very much higher dam.

"Mr. Davis, late chief engineer of the United States Reclamation Service, thought it should be carried still higher, but that is a problem we shall have to defer for a few years until more pressing needs are solved.

"At a point twelve miles lower downstream, at Early Intake, has been built the main aqueduct, practically 20 miles in length, between Early Intake and Moccasin Creek. All but 4,000 ft. of tunnel has been excavated on this work. It is programmed to have it finished, lined with concrete 16 months from date, when the power house will be all equipped, ready for service, and we shall have another celebration. This will develop about 300,000,000 kilowatt hours. There is a total now of 370,000 used in San Francisco and the great problem of the coming year will be to arrange a safe and sane handling of this enormous power crop. Practically 70,000,000 kilowatt hours furnish the City's immediate needs for street lighting and driving the municipal railways. The great question of the future is what to do with the other units of power to be developed and it will need all the statesmanship in San Francisco to sit down and help solve in a safe and sane manner this problem. There are possibilities for developing over a billion kilowatt hours of power still on this project, one by building a tunnel from Hetch Hetchy to Early Intake and putting in a power house at that point, which will develop possibly 80,000 hydro horsepower, another by building a high line canal from Eleanor to above Early Intake which will develop 40,000 horsepower. Other possibilities for power may be developed on the higher Cherry and other reaches of the City's watershed.

Stupendous Task Ahead

"The great present problem is to get a market for our existing power units, so that it will bring in a revenue and help to pay interest on the bonded indebtedness, and, secondly, to provide money to complete the aqueduct between the Moccasin Creek power house and Irvington. This will have practically 49 miles of tunnels and 45 miles of pressure pipe across the San Joaquin Valley, the cost of which will be practically $30,000,000. The rights of way are now being acquired for this pipe and pole line for a width of 110 ft. across the valley. Tunneling will be less difficult than the Sierra tunnel just completed, where enormous volumes of water were disclosed in shafts and made operations very difficult.

"The Bay Division of the project between Irvington and Crystal Springs reservoir, about 22 miles in length, is in a very forward condition. The Pulgas tunnel, through the Coast Range of hills, 8,700 ft. long, will be bored through inside of two months, and contract has been let for 21 miles of steel pressure pipe by which water from Calaveras and Niles Canyon can be brought across the bay at Dumbarton and placed in Crystal Springs reservoir.

"In obtaining our grants the government made a mandate that the City should develop power. Development of power in small units is not economically justifiable, so we can stand on the wisdom of the policy of developing an initial large power unit, even if it does promote controversy and discussion in the disposal of the product. There were many difficulties and controversies involved in undertaking the construction of this project.

Built Despite Critics

"The thought was suggested that we had no foundation for a dam of any kind. Others suggested that we move down the canyon half a mile. Many others suggested we use motor trucks instead of steam cars for handling our plant and equipment, and many others threw rocks through the plate glass windows for the pleasure of hearing the cracking glass, but in spite of all the critics this work has been carried to a final achievement.

"Our relations with the farmers of Turlock and Modesto have become most friendly and harmonious. They have built a large dam holding over 270,000 acre feet of water at Don Pedro. This makes

a lake that extends back as far as Jacksonville. Before this lake was filled we built a siphon conduit 9 ft. 6 ins. in diameter under the lake for our aqueduct to San Francisco. Part of our railway had to be elevated and changed across Six Bit Gulch, which was paid for by the Irrigation Districts of Turlock and Modesto, so that altogether our relations have been most friendly.

"The Department of the Interior and Department of Agriculture acknowledged the filing of all our maps and our relations with each of those departments have been very harmonious.

"Finally, my hope is that the future people of San Francisco will treasure it and guard it as one of their greatest inheritances."

Former Mayor P. H. McCarthy followed Mr. O'Shaughnessy, eulogizing the chief engineer and his staff of assistants, and paying tribute to Mayor James Rolph, Jr.

Placing of the plaque bearing the inscription, "O'Shaughnessy Dam," on a fountain on the dam was attended by a simple ceremony at which congratulations were extended to the Chief Engineer. Motion pictures of the scene were taken by the official cameraman of the Engineer's Department.

Visitors inspected all parts of the dam, descending several hundred feet into its depths and operating the valves through which million of gallons of water poured each minute.

At the time of the dedication, the reservoir was at its peak and the eighteen siphons were jetting forth hugh streams, which tumbled down the side of the dam in a great white sheet. The noise of the roaring siphons prevented the dedication ceremonies being held on the dam.

Has Natural Beauty

The O'Shaughnessy Dam and the Hetch Hetchy reservoir stand as a refutation to so-called "Nature lovers," who opposed its construction. Here, spreading for seven miles up the valley, lies a placid lake which is destined to become a magnet to all real nature lovers. Caught between two mountains and trapped by the barrier of stone and steel, it is a sight that would warm the hearts of those who delight in natural beauty. In the distance two waterfalls, like two immaculate ribbons, streak down the side of the canyon and are reflected in the huge man-made mirror. None has more accurately expressed the scene than the caption writer of a San Francisco newspaper, who placed the words over a photograph of the dam and reservoir: "Where Beauty and Utility Wedded."

Down the canyon, racing toward San Francisco, the water rushes for twelve miles through a stream as primitive as the day on which it was created. The river in many places is inaccessible, due to the steepness of the canyon. From the Early Intake diversion dam and portal the water will be transported in pipes and through tunnels for 156 miles to San Francisco. The total distance from the O'Shaughnessy Dam to San Francisco is 168 miles. En route this water will be diverted through power houses to develop electrical energy for the operation of municipal projects and sale to industries.

The flow of the water through the dam is regulated by twelve balanced needle valves. Six of these, which are 3 ft. in diameter, regulate the flow to San Francisco, and others, which are 5 ft. in diameter, control the flow which goes to the Turlock and Modesto Irrigation Districts, lower down the Tuolumne. The siphon spillway carries 15,000 cu. ft. per second.

The dam is constructed to allow for expansion and contraction, due to temperature changes. It is divided into blocks, separated by copper strips, where slight movement can take place.

Some Obstacles Overcome on Construction

The primitive nature of the surroundings in the Hetch Hetchy district and at the site of the dam was one of the many obstacles overcome in the construction of the dam. In order to get construction material into the mountain fastnesses it was necessary to construct the Hetch Hetchy railroad. The City built 68 miles of standard gauge system, starting at a junction with the Sierra Railway in the foothills. This road follows in a general way the line of aqueduct. A total of 300,000 tons of material will have been carried on this road before the project has been completed.

The road has also acted as a common carrier, transporting lumber from new mills in the adjacent forests and other freight for local inhabitants. While being constructed for carrying materials into the project, this road is probably one of the most scenic railways in the United States, running through a wild country where all manner of wild game can be seen from the trains and along the edge

of mountains overlooking sheer cliffs of several thousand feet.

Another obstacle encountered in the construction was the character of rock on which the foundation was placed. Most of the foundation work is 60 ft. below river bed, while some of the work is placed at a depth of 118 ft.

In beginning the work of construction, the Tuolumne River was by-passed from the site of the proposed foundation through a tunnel 25 by 25 ft. Four supplementary dams were needed to reach a foundation. A log crib dam was placed 200 ft. above the foundation site to divert the water through the tunnel. Then a down-stream dam was constructed to keep the water from backing into the pit. Two additional slender dams were then placed in the pit at a depth of 40 ft. to intercept water and gravel from coming into the bottom of the pit until the foundation had been reached.

Grooved pot holes were encountered at the bottom which were covered with the scum of centuries. A sandblast and brushes sufficed to clean off the granite base for a desirable contact for the concrete.

In August, 1921, the excavation work was completed and concrete was poured into the forms at the rate of 25,000 cu. yds. a month. This was continued until the day of the dam's completion, March 23, 1923.

Another large task in the construction of the project was the necessity of drilling an 18-mile tunnel through the Sierras, 9 miles of which will be lined with concrete.

More than 500 persons have availed themselves of the week-end excursions being promoted by the office of City Engineer O'Shaughnessy to the Hetch Hetchy reservoir and O'Shaughnessy Dam since its completion.

A special train leaves San Francisco every Friday evening, arriving at the damsite Saturday morning and leaving the dam site Sunday afternoon and arriving in San Francisco early Monday morning.

Under plans of the City Engineer's office a different group of business and professional men and women will be taken to the project each week. The trips are under the direction of Assistant Superintendent L. B. Cheminant of the Hetch Hetchy Railroad and can be made at a nominal cost.

NEED OF PROPER MAINTENANCE OF IMPROVED ROADS

By John S. Crandell, Consulting Engineer, The Barrett Co., 40 Rector St., New York, N. Y.

The Canadian Good Roads Association has for its slogan "Adequate Maintenance Means Road Economy." That is a pithy statement of fact. It would be well to teach it to school children so that it might be implanted in the minds of the maturing generation. There are many adults who never seem to be able to grasp the idea that road maintenance is a necessity. There are many voters who are willing and anxious to spend money for road construction but who are aggressively against any road maintenance fund. The task of educating these people to realize that adequate maintenance means road economy has been and continues to be difficult in the extreme. If we can start with the children and instill in them the idea of maintenance then a large share of our worry will be done away witth.

Severe Test of Roads

During the past year, winter and traffic combined have put our roads to the most severe test possible. Those roads that have consistently received careful, painstaking and intelligent upkeep have come through the ordeal in first class condition, while those that were slighted, skimped and neglected are now close to ruin. Last winter was especially severe, and traffic never was so heavy, so it was certain that only the best could come through intact. There was no type of improved road that was not injured, and in many cases the damage to the high cost roads was much greater than that done to the cheaper types. Many people still have the notion that because a road is expensive in first cost that it will be perfect forever and ever. Therefore maintenance is disregarded until suddenly the pavement breaks up so badly that reconstruction is necessary.

There are fertile regions in both Canada and the United States that are almost without inhabitants because the highways are so poorly maintained that communication with the markets is costly, difficult, and sometimes impossible. Municipalities are the natural markets for the farmer, and the townsman must take as much interest in the country roads as he does in his own municipal thorofares. Nor may he neglect the town streets, thinking to use the provincial highway system when he wants to ride. All too often the motorist leaves a splendid country

road and enters a wealthy city over really abominable pavements.

Value of Well Trained Maintenance Crew

The trouble with most roads and pavements is not faulty construction but lack of adequate maintenance. It is not necessary in the smaller cities to keep an expensive maintenance crew of a large number of men working all the time. But you must have a small gang trained to maintenance work, on whom you can depend for faithful service. This gang may be used for construction work, too, but its primary reason for existence is to be ready any day to maintain the highways. When a break in a pavement appears this gang of three or four men will immediately patch it. When chains on motor cars wear ruts in the surface of the pavement these men will repair the damage immediately. When the small boy builds a bonfire on the new road the gang will be on hand next morning to remove the burned pavement and patch. When the weather is bad the gang will be making up cold-patch mixtures to be used when the weather is good. And when they have all the pavements in town in first class shape they will be turned over to construction work until they are again needed on maintenance.

Townships and counties need maintenance gangs or maintenance men just as much as the towns. The more progressive localities have realized this and

VIEWS SHOWING THE BAD EFFECTS OF POOR DRAINAGE.

Upper View Shows Concrete Road at Spring Valley, N. Y., Built in 1912, Being Covered with Tarvia A and Limestone Chips in July, 1922. Middle View Shows the Condition of the pavement in November, 1922. Lower View Shows the Same Place in April, 1923. The Pavement at this Point is in a Cut and Water Seeped Under the Slab and Heaved in Freezing. Only this Section was Damaged; the Rest of the Pavement Came Through the Winter in Perfect Condition.

they are cashing in on their foresight now. Traffic is coming their way; their hotels are full, their merchants are doing good business, their farmers are prosperous, and the towns are in flourishing condition. But let maintenance slacken ever so little and a difference will immediately be felt. Trade lags, tourists stop, farmers travel less and stagnation appears.

We must have good roads, and that means we must maintain them.

As traffic increases, the task of maintaining our improved roads becomes greater and greater, and the longer we defer maintenance the more formidable it grows until finally, if we wait too long, it is a matter of reconstruction rather than maintenance.

Maintenance and Reconstruction

How shall we differntiate between maintenance and reconstruction? Is there any line of demarkation between the two? Can we say that if we apply surface treatments of tar to macadam or bituminous or concrete roads that that is maintenance, but that if we apply a 2 in. wearing course over an old road that is construction or reconstruction? There are a number of road authorities who believe that once the road is constructed it is always a question of maintenance, no matter what is done to the road, unless there is relocation and new drainage. This is the extreme view, and probably most highway officials will not concur in it.

Pavement Characteristics

Pavements are as individual as persons. Some stand up and take punishment under adverse conditions for a long time before they fail, and then they go all to pieces. Others fail gradually, a hole develops here, a wave there, a stone comes loose, a slight depression, and slowly the pavement becomes worse and worse until it is almost impassable. Some go bad in spots, just as a man becomes bald. Some, like the old cow, just "give out" from no apparent cause. Some begin to crack and break up as soon as they are laid, while others scale and peel as though they had some skin disease. And you never can tell how they are going to act, even though you know all the facts about their construction, because traffic and weather may bring about conditions wholly unforeseen.

New or Careless Maintenance Gangs

But as soon as trouble is noticed, maintenance of the most painstaking kind should be begun. Now I said "painstaking, and I mean just that. An examination of the roads throughout the eastern part of the United States this Spring convinced me that the maintenance gangs have either grown careless, or that new gangs are at work who do not know their business. The patching, filling of cracks in concrete, cleaning of ditches and culverts, repairs to guard rails, and the upkeep work in general is not nearly so good as it was a year ago. While I admit that there has been vastly more of it to be done this year, and that the men have had to work faster to keep up with the breakdowns, it still remains a fact that the work has, in many cases, been carelessly done, with almost total disregard of instructions.

Patching With Refined Tar

Successful patching with refined tar does not call for any great skill, but it does call for a lot of common sense. And to be quite successful in this class of work a little experimenting should be encouraged. Tarvia KP, which is so extensively used for cold patching, is a uniform product, so that no matter where it is purchased, it will be found always the same. But the tar that goes into a patch is only about 10% of the total material. The other 90% is stone and sand or stone alone. Stone varies with its location in the quarry as well as with its geographical position, yet many road men take no heed of this variation, and make up all their batches of patching mix as if the stone were as uniform as the tar. Sands, too, vary greatly. There are hard sands, and soft sands, sharp sands and round sands, clean sands and dirty ones. It stands to reason that a hard stone, like trap, will not produce the same kind of mix that a soft limestone will. Nor will granite, another hard stone, act like trap. Nor will all granites act similarly. Then again, the sand that is generally used in the mix will make considerable difference in the way that the stone itself acts. A little experimenting will enable you to determine what is the best proportion of materials to use. Then, having found by trial the best mix, stick to it, and make all your other mixes with the same materials and in the same way.

Many of the soft limestones need no sand. The sand is a filler to fill the voids between the pieces of stone, but when soft limestone is used there is considerable fine material worn off the stone which takes the place of sand. This is not the case when the harder stones are used. A mix made of hard stone alone will usually be unsatisfactory because the patch will be an open mix, water can

enter it, and disintegration is almost certain to result.

There are a few roads that require patching only. There are others that require more extensive maintenance. Patching takes care of actual breaks, while a surface treatment saves the surface and keeps the pavement intact.

Tar Surface Treatment of Concrete Roads

New York State during 1922 maintained many miles of concrete with tar surface treatments. In this work both hot tar and cold tar applications were tried. The hot tar seems to provide a more durable coating, and a mat is built up of considerable thickness. The hot applications require greater care, both in original work and in maintenance, but the results seem to indicate that such care is well repaid. Where hot applications are made it is necessary to cover the tar with ¾ in. hard, tough stone chips. A sand cover will not do. The large sized chips are rolled into the tar where they are anchored fast. The large chips prevent any waving or bunching of the tar coating, and they also provide an excellent surface for both motor and horse drawn traffic. Such a surface is really skid-proof.

Amount of Tar Used

The amount of tar used for the hot surface treatments is about ½ gal. per sq. yd. of surface. This is sprayed over the concrete in one application. Sometimes it is better to give the concrete a priming coat of cold application tar at the rate of ¼ gal. per sq. yd., following this with 1/3 gal. of hot tar. This method will be found to be best when the concrete is scaling badly or where the laitance is not worn off evenly. When cement concrete sets there is a sort of scum that rises to the top, forming a layer much like icing on a cake. This is called laitance. It wears away in the course of time leaving the aggregate of the concrete exposed to traffic. It is then that the tar surface treatments are necessary and advisable. But do not attempt to surface-treat a new concrete road unless the laitance is removed in some manner, for the tar will peel up with the laitance, leaving the concrete unprotected.

If the concrete wears so badly that a surface treatment does it no particular good, then a 2 or 3 in. tar penetration macadam toppng should be laid over the concrete. If the concrete breaks up in springtime it is a sign that drainage is the fault, and no top or maintenance of any kind will help. During March and April of this year I saw many concrete slabs badly heaved and broken because the soil had not been properly drained before the pavement was laid. There is, of course, no way of maintaining a pavement of any kind under such conditions. It is useless to put a tar wearing course on top of a poorly drained concrete road, for if the concrete heaves and cracks so will the top.

The Macadam Road

The macadam road is by far the best road for horse drawn traffic, but the macadam road, as all very well know, does not last under motor cars, unless it is protected by giving it some kind of a bituminous surface treatment. Then, with careful maintenance, there is no good reason why a macadam will not last indefinitely unless heavy motor truck traffic appears.

Immediate Repair of Surface Breaks

Macadam may be either water-bound or tar-bound. The latter type, of course, gives a more lasting and stronger pavement. Maintenance is carried out in the summer for both types. It is extremely important that all surface breaks be repaired as soon as they appear. For this purpose it is wise to keep on hand a few barrels of light refined tar so that patches may be made at any time. Some states scatter barrels of patching material along the roads, so that the repair men may have a handy supply. The barrels should have a tight fitting cover to keep out dirt. At convenient places there should be kept supplies of stone. There will be no excuse for roads not being always in good condition, provided the drainage is right.

Practice in One Small City

Every year or two the road should be surface treated with light refined tar applied at the rate of from ½ to ⅛ gal. per. sq. yd. The amount varies with the condition of the road to be treated. New waterbound macadam requires about ½ gal. for the first treatment. This should be reduced each year until the thinnest coat that will protect the road is applied. One of the best paved small cities I ever saw was in Pennsylvania where nearly all the streets were built of waterbound macadam and treated yearly with Tarvia B applied at the rate of 1/10 gal. per yd. The streets were always in perfect condition, and the cost of maintenance was less than 2 cts. per yd. per year. This was before the war, but even now the cost is not 3 cts. The business streets are tar macadam, and are surface-treated annually. The low cost resulted from the city engineer sitting personally on each

job day in and day out, and the excellence of the work was due to the same cause.

Avoid Heavy Mat Coats

It is a mistake to apply too much tar year after year so that heavy mat coats are built up. Often it is better merely to patch the breaks, and surface treat every two or three years. I have seen failures come where the engineer insisted on treating little used streets with ½ gal. per yd. yearly. Unless the road is flat it is difficult to apply as much as this to a surface that has had a treatment, for the tar will run to the gutters. Excessive maintenance like this may be worse than none at all.

Tar-bound and asphalt roads require surface treatments from time to time. Asphalt may be kept in good condition with an occasional tar surfacing. The tar surface treatments over asphalt prolong the life of the asphalt in a rather odd way. Oils from motor cars soften asphalt to such an extent that on heavily travelled streets rutting occurs. Ruts over an inch in depth are often formed and it is impossible to roll them out or to harden asphalt. Tar is not affected by the oil and it therefore oil proofs the asphalt and prevents it from ruttting, bunching and pushing.

The foregoing is from an address before the recent Convention of the Union of Quebec Municipalities.

COMMENTS ON THE COLORADO RIVER PROBLEM

By C. E. Grunsky, Consulting Engineer, 57 Post St., San Francisco, Calif.

Among the larger of the domestic problems with which this country is immediately concerned is the Colorado River problem.

International Aspects of the Problem

By inaction the international aspect of this problem is annually growing more serious. As advisor to the Secretary of the Interior on such matters the writer in 1907 called attention to an intolerable situation and suggested a plan of procedure to prepare the way for the pending interstate and international projects. It is perhaps not generally known that by indirection rights are held by the Imperial Irrigation District of California, through a subsidiary Mexican concern on foreign territory, entirely without treaty sanction or protection and subject to conditions which may become embarrassing if a suitable treaty arrangement with Mexico be too long delayed.

The Interstate Pact

The Colorado River problem can not be solved without giving proper consideration to the fact that this river is an international river. The interstate pact, recently agreed to by a commission composed of a representative from each of the seven states in the watershed of the river and Mr. Herbert Hoover, as representative of the United States, and now ratified by all of the watershed states except Arizona, is only a first step toward the solution of the problem. If conflicting interests between upper and lower groups of states are to be recognized as indicated in the pending pact then, too, the states within the two groups may well ask as does Arizona, "What will be the situation 40 or 50 years from now?" Each of the states in the upper group is interested in knowing what proportion of the water agreed to be left in the river for the use of the lower group it will be expected to furnish—just as each of the states of the lower group may desire to know at the outset what proportion of the water and what proportion of the power output will ultimately fall to its share.

The Position of Arizona

It is not surprising then to find Arizona, with a limited area only that can profitably be covered with water, in the attitude of wanting to know. There is some basis for the fear that if, for example, the Boulder Canyon dam be constructed and a power plant be there placed in operation, the predominating benefit will go to those regions where industries are already well established—that the southern portion of California will absorb an undue proportion of the energy made available at the cost of Arizona's future. A similar fear is expressed in the matter of the beneficial use of water for irrigation. Who, if there be no understanding on this point in advance, shall prevent the extension of irrigation to the most favorably located lands regardless of state boundaries to the exhaustion of the water supply, thereby possibly depriving one state or another of making developments which, though perhaps not immediately attractive from an economical standpoint, may yet be of equal or greater value in a broad scheme based on ultimate greatest good to the greatest number?

Interstate Power and Irrigation District

No reasonable regulation of the flow of Colorado River by storage appears feasible except under control of some higher authority than that of the individual

state. This principle has already been recognized in the creation of the Commission which has formulated the interstate pact. The federal government is the agency that should logically be looked to, to effect the regulation and to apportion the output. But, there may be objection to the vesting of this control in the United States, burdening the nation with a problem which primarily concerns the Southwest, and some thought must be given to the alternative to which attention was called in a recent address by Governor Scrugham of Nevada, at a meeting of the Pacific Coast Electrical Association, which provides for the formation of an interstate power and irrigation district. This is a practical suggestion and if those who are directly interested prefer the district control to federal control, why not?

The Time Element

An interstate district, however, could not, any more than the United States, prevent development along the lines of least resistance regardless of state boundaries unless there be some prearrangement between the states to restrict undue demands upon water and power output in the localities whose other facilities are already well developed. The time element must, in other words, be taken into account and the desirable ultimate conditions must be forecast and carefully weighed. State boundaries will have to be considered although it is self-evident that in such large problems as that of the Colorado River the ideal solution should be independent thereof, except that their recognition may aid in securing desirable widespread, rather than concentrated, utilization of both water and power.

How Much Water Should Go to Mexico?

But it must not be overlooked, as already stated, that the Colorado River problem is an international problem. We may take satisfaction in the knowledge that the water in this river originates in the United States and that if we retain and use it all within our own borders our neighbor to the south would have to be content with a protest. This will never happen. Thus far we have failed to set a limit to the amount of water which is ultimately to be allowed to flow into Mexico and the irrigated area in Mexico has been growing apace. On this subject our government was warned, as already stated, in 1907, when Colorado River water was used in Lower California on less than 10,000 acres. Now the irrigated area in Lower California is about 200,000 acres. What shall be the limit, and what agency other than the United States can fix the limit?

Here is a case where the limit is not set by the physical features of the country, but solely by the quantity of water temporarily and ultimately available.

Inundation Dangers

And again, the Colorado River menaces certain areas within the United States with inundation when its waters run wild. The great menace is to the lands of the river's delta lying both in the United States and in Mexico and the points where this menace must be fought are in Mexico. To be sure the frequency of floods can be materially reduced and the rate of channel deterioration by silt deposits can be materially decreased with such works as the contemplated Boulder Canyon dam, but some of the flood waters originate in portions of the river's watershed below Boulder Canyon and these would still remain to keep acute the situation in the river delta beyond our boundary.

Federal Control of Proposed Large Reservoirs

Owing then to this international aspect of the question the United States should remain in control of any proposed large reservoirs on the Colorado River even though construction and operation thereof subject to government regulation be delegated to a district, to a state, to a group of states, or to a private corporation. It will remain incumbent on the United States to arrange for the manipulation of reservoir gates in such fashion that the flood menace will be reduced to a minimum and that interstate and international obligations will be respected.

PROPOSED ELECTRIFICATION OF THE AUGUSTA, GEORGIA, POWER CANAL

By Nisbet Wingfield, Consulting Municipal and Hydraulic Engineer, Marion Bldg., Augusta, Georgia.

The City of Augusta, Georgia, is located on the Savannah River, which stream forms the boundary line between the States of Georgia and South Carolina. It is where the Fall Line joins the Costal Plain, and is at the head of navigation, 202 miles by river from the Port of Savannah, Georgia. It is one of the old Southern towns, being established as a trading post in the Colonial Days, and incorporated as a town shortly after the Revolutionary War.

Character of Business and Industries

The people of Augusta are conservative, but industrious, and have built up a community which is not only sound socially but industrially. It is a noted tourist resort, but this is merely by-the-way, as the business of the community does not depend on tourists.

The most important business is the handling of raw cotton and its manufacture into cloth. Approximately one-half million bales of cotton are marketed in Augusta each year, and much of this is used by the various cotton mills in the city and immediate suburbs.

River steamers are operated from Savannah to Augusta. These make connection at Savannah with ocean-going vessels, and in this way an all water freight rate is established between Augusta and Eastern ports. Cotton and cotton goods are shipped from Augusta in this way, and miscellaneous freight brought back. Owing to the advantageous freight rates, jobbers of all kinds of merchandise can operate from Augusta to advantage.

Another important industry is lumber, there being many planing mills and woodworking establishments. These are supplied from saw mills cutting long leaf and short leaf pine in the immediate vicinity. There are also boiler works, machine shops and various industries usual in a city situated as Augusta is, supplying a large territory surrounding it.

Present Sources of Power

Practically all industries in and around Augusta, including cotton mills, are operated either by electric power or by water power, applied direct to the shafting by means of water wheels, as is the case with the industries supplied from the Augusta Power Canal, which will be described more in detail below.

There are two sources of power; one is a hydro-electric development made by damming the Savannah River eight miles above Augusta, where a fall of 28 ft. net is obtained, and 16,000 electrical horsepower produced. This was constructed, and is owned, by a corporation chartered as the Georgia-Carolina Power Company. The other is what is known as the "Augusta Canal," a development made many years ago, before any one had heard of, or thought of, electric power and transmission lines. The Augusta Canal furnishes a total gross power of 12,000 horse-power.

Need for More Power

The entire capacity of both of the above mentioned developments is now being utilized by existing industries and street lighting. Applications are constantly being made for power from prospective consumers who desire to build in or near Augusta, and from existing consumers who desire to increase their plants.

Augusta being quite a distance from the coal fields, it is not practicable to put in steam plants and compete with electric power developed in the immediate vicinity, so that if the city is to grow and increase its commercial importance as it should, it is necessary to develop an additional supply of electric power.

How Additional Power Can Be Obtained; Possible Sites for Hydro-Electric Development

A study of the topographical maps of the Savannah River Basin and profiles of the main streams, all of which were available, discloses a number of sites where hydro-electric developments could profitably be made.

The total areas of watershed above Augusta is 7,295 square miles. This extends back to the foothills and mountains of the Blue Ridge Range, reaching an extreme elevation of approximately 4,000 ft. above sea level.

The fall is quite rapid from the upper end to the Piedmont Plateau, where the elevation is about 1,000 ft. From that elevation to elevation 100 (which is zero on the river gauge at Augusta), the fall is more gradual, but there are a number of rapids and shoals offering excellent opportunities for development.

From Augusta to Savannah the river passes through the costal plain, the fall averaging only about one-half foot to the mile, so there is no opportunity for development below Augusta.

The drainage system above Augusta consists of the Chattooga and Tallulah Rivers, which form the Tugaloo, and the Tugaloo and Seneca which form the Savannah. The principal tributaries below the junction of the Tugaloo and the Seneca, are the Broad River from the west and Stevens Creek from the east. The fall in the Tugaloo from the junction of the Tallulah and Chattooga to the junction with the Seneca River (a distance of 50 miles), is 260 ft. From the junction of the Seneca and Tugaloo to the Georgia-Carolina Power Company's Pond (a distance of 80 miles), the fall is 300 ft.

The fall from the Georgia-Carolina Power site to Augusta, seven miles, is 50 ft.

On the Savannah River and tributaries above Augusta, there are 18 possible sites for hydro-electric plants. Some of these, in the upper reaches, have too small

drainage areas to make them of much value alone, but as a part of a general scheme they would become of great value, as the power at any given plant is increased by each development above it, on account of the increase in pondage to be drawn on during periods of low water in the river.

Development for large powers must necessarily be located on the lower reaches of the main stream in order to have sufficient drainage areas to insure a reasonable flow during dry seasons.

If all developments commercially possible were made on the Savannah River and tributaries, the total power thus secured would be more than 200,000-h. p. No other stream in this section of the United States has such possibilities.

With this fact clearly demonstrated, and it has been by numerous surveys and reports made both by the United States Government and individuals, it seems peculiar that more power developments have not been made in this basin; but the cause of this is clear, if unjustified. Every attempt made by individuals or corporations organized for the purpose of developing these powers, to finance a proposition, has been met with the statement that there was no market for the power within a reasonable distance of the development, and the prospective bond buyers and underwriters (with whom negotiations had been opened) stressed the fact that the quantity of power furnished by the "Augusta Canal," and the low rate at which it was delivered to the mills, made it impossible for any other development to compete in Augusta.

The prerequisite for considering the financing of a proposed development was that actual contracts for the power must be obtained in advance of improvement. This was manifestly impracticable, as the power must first be available before new consumers could be found.

The Georgia-Carolina development at Stevens Creek on the Savannah River was financed by obtaining a contract from the Augusta Railway & Electric Co., by the terms of which the Railway & Electric Company obligated itself to pay annually a sum sufficient to meet interest on all the Power Company's securities. It required several years to find consumers for the power, but all has now been sold.

From the above it will be seen that it will be difficult to induce the owners or promoters of any of the privately owned sites of the Savannah River watershed to develop any of their properties, on account of the difficulty or impossibility of financing the construction, so that it is evident that additional power, if any, must be provided by the City of Augusta itself. The cheapest and most sensible method of doing this is by converting the old antiquated August Power Canal into a hydro-electric plant.

The Original Power Development by the City of Augusta

In 1845 certain influential citizens of Augusta decided to go into the manufacture of cotton goods, and for this purpose to utilize some of the power in the Savannah River. In the first seven miles above Augusta there is a fall in the river bed of approximately 50 ft. The scheme evolved was to build a canal with a low gradient from a point about seven miles above the city down to Augusta, and utilize the fall from this canal to the river for the development of power. In those days, of course, hydro-electric development was unknown. A canal was constructed connecting with the river above the city, followng the hillside to Augusta.

The dimensions of this were 40 ft. surface width, 20 ft. bottom, and 5 ft. deep. A timber diverting dam was put across the river at the upper end to force the water into the canal. A head of approximately 32 ft. was secured, affording a total mechanical effect of about 600 h. p. This amount of power soon proved inadequate to the demands, and as the plant functioned perfectly, it was decided to enlarge the capacity, but for reasons now unknown, this was not done until after the Civil War.

The Present Power Development

The enlargement was finally authorized in 1872. The work was commenced in March of that year, and completed in July, 1875. The new development was along the same lines as the old. The extreme low flow of the river at Augusta is 2,300 cu. ft. per second. This stage of water has occurred only once. The annual low flow is between 3,000 and 3,400 cu. ft. per second, the ordinary summer flow is 5,000 cu. ft. per second. At flood periods this is largely increased, the record flood (1908) being 300,000 cu. ft. per second, or 100 times the ordinary low flow. It was decided to construct a canal capable of delivering to Augusta the ordinary low flow of the river that is, 3,400 cu. ft. per second.

A stone masonry diversion dam was constructed across the river from the Carolina shore to the Georgia shore, just below the old timber dam. The spillway

is 1,700 ft. long and the crest is at such elevation as to maintain 11 ft. depth of water in the canal. The minimum waterway in the canal is 150 ft. at the surface, 106 ft. at bottom, and 11 ft. deep, making an area of cross section of 1,408 sq. ft. The length of the canal is 7 miles. There is a bottom grade or descent in the main canal of one hundredth of a foot in 100 ft. This will give, theoretically, a mean velocity of 2.75 ft. per second. The flow into the canal is controlled by head gates with a combined area of openings of 1,463 sq. ft. One side of the canal is an embankment constructed along the river of materials excavated from the canal channel. The other bank is the natural soil. There were several small streams flowing into the river in the distance of seven miles covered by the canal. Where these were encountered flood gates were placed in the canal bank. In ordinary operation, however, these are closed, and the creek or branch water flows into the canal. If the rainfall is of such intensity as to raise the water level in the canal to a danger point, these gates are opened.

In addition to the gates several spillways have been provided with a total length of approximately 300 ft., the top of the spillway being 6 ins. above the established flow line in the canal.

Method of Utilization

From the diversion dam above the city down to Augusta, there is a rapid fall in the bed of the river, the total difference in the elevation being approximately 50 ft. The fall in the canal for the same distance is 3½ ft., so that difference in elevation of water in the canal and river increases from nothing at the Locks to 46½ ft. at Augusta. At points along the canal where differences in elevation between the canal and river are sufficient, various industries have been established, located between the canal and the river. The agreement between these industries and the City of Augusta (owner of the canal), is that the city will furnish and the industry pay for, water at the head gates, which are constructed in the banks of the canal. Water is drawn through these gates and head races to the water wheels and tail water goes to the river. The city makes an annual charge of $5.50 per h. p. year, for 11 hours per day. This is for theoretical water power at 100% efficiency, regardless of loss from friction or head at which water is used. The city's charge is based on horse power developed, and not on quantity of water or head available, the actual head only being taken into consideration in determining the charge. As the cost of the entire development, including head gates, head race, wheel pit, water wheels and tail race, is paid by the consumer, this basis of charge encourages uneconomical use, and in consequence, many of the industries have not utilized the full head available.

The Augusta end of the canal is so located that it is impracticable to get tail race from the industries direct to the river, and it was found necessary to build an intercepting canal, known as the "Second Level," into which the tail water from the factories located in the congested districts emptied. The industries so located have a head of only 15 ft. There are a few small plants which take water from the "Second Level," and empty into a "third level," which is merely a drainage canal, flowing into the river.

In each case, both on the first and second levels, the industries have made their own developments. Two of the cotton mills have electrified their plants, using the water obtained from the city to operate plants of their own.

Loss of Available Power by This Method

The present method of obtaining power from the Augusta Canal is not only antiquated, but wasteful in the extreme. In the first place, only one mill has developed power in such a way as to utilize even approximately, the entire fall available. There is a further waste of power thus developed in the manner in which it is transmitted to the machines. The water wheels mechanically drive line shafts, entailing high frictional loss, in some instances in the larger mills amounting to 40%. There is a further loss entailed when only a portion of the machinery is being operated, instead of the full load, the factories drawing practically a constant amount of water regardless of any variations in their loads.

The loss of power due to insufficient head is especially noticeable on those mills, four in number, taking water from the first level, and discharging tail water into the second level, with available fall of only 15 ft. These mills use 1,188 cu. ft. per second to develop 1,571 h. p. or 1.32 h. p. per cu. ft. of water. The mills discharging tail water directly to the river, consume 2,219 cu. ft. to develop 10,615 h. p. or 4.78 h. p. per cu. ft. of water.

In addition to the above there are losses due to depreciation and upkeep of numerous head works, gates, flumes and

other parts of the plants as against similar losses in one central station.

Development Proposed

In order to make available the power which is lost through the present system, which power could be used for additional industries, it is proposed to build a single new hydro-electric power plant near the foot of the shoals at Lake Olmstead, 4½ miles below the diversion dam, where a net head of 38 ft. can be obtained while the plant is in operation, the head water to be taken from the canal. Below this point the canal would be abandoned, but all the mills now drawing their water from the canal would, in lieu thereof, be supplied with electric power at a price to be agreed upon.

From this central plant a transmission line would be run along the canal. As the power obtained from the old system costs the users considerably in excess of $30 per h. p. per year at the machines, in spite of the fact that the initial cost of water is only $5.50 per h. p. it will not be difficult to reach an agreement as to the price of electric power which will enable the city to cover all costs of operation, depreciation and interest.

Possibilities of Increase in Power

The capacity of the canal as now constructed is 3,400 cu. ft. per second—the fall at the point selected for generating station is 38 ft. net. This will make available, after deducting transmission loss, approximately 11,000 electrical h. p.; 7,000 h. p. will operate the machinery in all the mills as it now exists, leaving a surplus of 4,000 h. p. to be sold. In addition to this, the capacity of the new plant can be further increased by raising the head of the water at the locks, thus increasing the delivering capacity of the canal. An 18-in. additional head can be obtained by raising the height of the dam across the river, which can be cheaply done, as the dimensions of the dam are such that 18 ins. can be placed on top without endangering it. It will be necessary also to raise the canal bank 18 ins. to 2 ft., a distance of 4½ miles from the locks to the power house site. This can be done with earth excavated from land side of canal. If this is done a total of 4,900 cu. ft. per second can be delivered at the power house, thus adding an additional 4,800 h. p. This additional amount of water will be available, although it is in excess of the low flow of the Savannah River, on account of the pondage by the Georgia-Carolina Power Company, which has a dam across the river, one mile above the city's diversion dam. During the day run the volume of tail water from this plant is approximately 5,000 second feet.

Effect on Present Users of Power

If the mill machinery is electrically driven, instead of the hydraulic drives at present, there will be a saving to the manufacturer in several ways.

It is a well known fact that power applied direct to the machines will give a more uniform speed than can be obtained from long lines of shafting driven from one end by water wheels. Uniformity of speed insures a better quality of cloth, and there will be less loss due to defective weaving.

It is also true that actual energy necessary to drive a certain set of machines is little more than one-half, if power is directly applied to machines, of the gross water power necessary to drive the water wheels mechanically connected to main driving shaft, which in turn drives countershafts, belted to machine units.

The cost of operation and upkeep of head and tail races, head gates, water wheels and all accessories will be entirely eliminated. This is a large item in any plant which has been in operation for some time.

On account of the reduction in operating expense due to decreased gross power required, and elimination of expense of operation and upkeep of the hydraulic drives, and the reduction in losses due to variable speed, the user can afford to pay such a price for the electric power as will enable the city to make the development.

Advantages to the City

The advantage to the city will be the fact that the mills and other industries which now utilize the entire power of the canal as at present developed, can be furnished with electric power sufficient to run all existing machinery and still leave a surplus of power to be sold to new industries, or for increasing any existing industries.

The rate to be charged for electric power will be such as to pay the interest on the cost of development, and this will in no wise be a hardship on the user, in view of the fact that a less amount of power will be required. It is necessary for the further development of the city that additional power be secured, and the power development referred to above can be made quicker and cheaper than in any other manner.

Present Status

The City Council of Augusta is desirous of making this improvement on its own account, thus retaining control of the

power situation in Augusta as at present, the object being to make rates as low as consistent, in order to encourage the erection of new manufacturing industries.

There is also before the City Council for consideration, a proposition from private interests to furnish the necessary capital to make the hydro-electric development from the canal, a corporation to be formed to control the power, the city having one-half interest, and those making the development one-half interest.

This latter method has been proposed in view of the fact that the constitutional limit of indebtedness for municipalities in Georgia will be exceeded if the city makes the development itself, requiring certain changes in State laws. There are, as usual, advocates among taxpayers for both plans. Which plan will be adopted has not been determined, but the improvement will no doubt be made one way or the other.

In the foregoing I have purposely avoided all technical terms and discussions—my idea being merely to present a situation which, in my experience at least, is unique.

AN IMPORTANT HYDRAULIC FACTOR IN CULVERT DESIGN

By C. E. De Leuw, Kelker De Leuw & Co., Consulting Engineers, Conway Bldg., Chicago, Illinois.

Design of culverts with due regard for their hydraulic properties has seldom been attempted in the past. The ever increasing scale of labor and material costs is causing the designing engineer to make a more critical examination and analysis of his designs of all structures. Culvert designs have generally been made on the basis of waterway opening required without regard to the effect of friction losses of different materials upon the velocity of flow. In the last few years there has been an increasing amount of discussion of friction losses as well as other hydraulic factors which affect the capacity of culverts.

The Iowa Experiments

A comprehensive investigation on the flow of water through pipe culverts was conducted at the hydraulic laboratory of the State University of Iowa during the summer of 1922. Tests were made on commercial corrugated metal pipe of 12, 18, 24 and 30-in. diameter. To determine the effect of the length of the culvert on flow, the 24-in. pipe was tested in 24, 30 and 36-ft. lengths. The other sizes were tested in 30-ft. lengths only. The number of tests (almost 1,000) warrant considerable confidence in the results obtained. The experiments were conducted by D. L. Yarnell, Senior Drainage Engineer, Bureau of Public Roads, U. S. Department of Agriculture, and Sherman M. Woodward and Floyd A. Nagler, Professor and Associate Professor, respectively, of Department of Mechanics and Hydraulics, State University of Iowa.

These investigators made a study of a number of hydraulic factors in culvert design such as entrance losses for different types of entrances, effect of carying elevations and culvert and the coefficient of roughness "n" in Kutter's formula. From these experiments, the following average values of the coefficient of roughness were found.

Diameter of Pipe Inches	Kutter Co-efficient Corrugated Metal Pipe
12	0.019
18	0.022
24	0.022
30	0.023

Earlier Tests

These results check with the somewhat meagre data obtained prior to these tests for corrugated metal pipe. In 1913 Cone, Trimble and Jones conducted tests on a semi-circular corrugated metal flume having an arc length of 132 ins. and a total length of 1,745 ft. The coefficient of roughness ("n") obtained varied from 0.0196 to 0.027, depending upon whether the flow was measured on a tangent or on a curve. In 1917 the Bureau of Public Roads conducted tests on 8-in. and 10-in. corrugated metal pipe 200 ft. in length. The coefficient of roughness ("n") obtained for the pipe flowing full varied from 0.017 to 0.021.

There is an abundance of data available on the values of "n" for concrete pipe. Many tests have been made not only in the laboratory, but also in the field on structures of great length and built under varying conditions.

Data From Bureau of Public Roads

The Bureau of Public Roads of the United States Department of Agriculture published Bulletin 852 on "The Flow of Water in Concrete Pipe" in 1920 which contains the data gathered from a great many tests. Many of these data were from the records of the U. S. Reclamation Service and also from the leading consulting engineers in many sections of the United States and Canada. Tests of many existing concrete pipe lines, including the Victoria, B. C. Aqueduct which is 42 ins. in internal diameter and 27 miles

TABLE I—DISCHARGE OF PIPE CULVERTS ON A ONE PER CENT. GRADIENT.

Internal Diameter of Pipe Inches	Water Area in Square Feet	Discharge of Corrugated Metal Pipe in Cubic Feet per Second	Discharge of Concrete Pipe in Cubic Feet per Second	Carrying Capacity of Concrete over Corrugated Metal Pipe Percent
12	0.79	1.83	3.40	86
15	1.23	3.44	6.35	85
18	1.77	5.70	10.17	79
24	3.14	12.70	22.78	79
30	4.91	23.60	41.73	77
36	7.07	39.10	68.22	75
42	9.62	59.45	102.93	73
48	12.57	85.84	147.44	72
54	15.90	118.14	201.61	71
60	19.64	157.91	267.30	69

in length, are presented. This Bulletin is the most complete and authoritative work on the value of the coefficient of roughness for concrete pipe. After reviewing all data presented, the following suggestions are made for "n" in Kutter's Formula:

Class 1. (Old California cement pipe lines.) n=0.013 for pipes up to 10 in. in diameter.
n=0.014 for pipes from 12 to 24 in. in diameter.
n=0.015 for pipes from 26 to 42 in. in diameter.

Class 2. (Modern "dry-mix" concrete pipe and monolithic concrete pipe or tunnel linings made over rough wood forms.) n=0.013 for pipes up to 36 in. in diameter.

Class 3. (Small "wet-mix" pipe in short units; "dry-mix" pipes in long units; average monolithic pipe made on steel forms.) n=0.012 for pipes up to 24 in. in diameter.
n=0.013 for pipes more than 24 in. in diameter.

Class 4. (Glazed—interior pipe lines; monolithic pipe lines where all interior surface irregularities are removed—only highest grade of workmanship and materials.) n=0.011 for pipes from 12 to 24 in. in diameter.
n=0.0115 for pipes from 26 to 28 in. in diameter.
n=0.012 for pipes more than 50 in. in diameter.

Comparisons Between Concrete and Corrugated Metal Pipe

It will be noted that the coefficient of roughness increases with the increases in diameter of both concrete and corrugated metal pipe. For the purpose of making a comparison, however, this slight variattion has been neglected. In order to compare the carrying capacities Table I has been prepared showing the capacity of various sizes of pipe. For concrete pipe a value of "n"=0.013 is used, because the character of workmanship and finish of a culvertt is not generally of as high a grade as in sewer construction. Reference to the above table of values, suggested in Bureau of Public Roads Bulletin 852, will indicate that this value of "n" gives a proper factor of safety. For corrugated metal pipe a value of n=0.021 is used. The pipes are figured as flowing full. The entrance and velocity losses are disregarded as they are practically the same for each material with a given type of entrance.

Similiar computations were made for pipe culverts of the same materials on different gradients and show that the percentage of comparative capacity is independent of the gradient. The practical application of these data in highway construction is apparent. It can be seen readily that a 12 in. concrete pipe can be substituted for the 15 in. corrugated metal pipe, a 15 in. concrete pipe for an 18 in. corrugated metal pipe, an 18 in. concrete pipe for a 15 in. corrugated metal pipe, the substitutions continuing in the same proportion as the diameter of the pipe increases.

TERRE HAUTE MEMORIAL STADIUM

By George J. Stoner, Vice President and Secretary, Shourds-Stoner Co., Architects and Engineers, Terre Haute and Chicago.

The Terre Haute Memorial Stadium, now in course of construction is being erected by the Board of Park Commissioners of the City of Terre Haute, Indiana, in Stadium Park, formerly the old County Fair Grounds, which is located at the Eastern edge of the City on Wabash Avenue, which is the principal business thoroughfare of the city and which is also on the National Highway.

Terre Haute has long felt the need of an adequately housed athletic field. This was brought especially to the attention of the Park Board last year when the Terre Haute Base Ball Club won the

Three-I League pennant for the first time in twenty years. The ball park used by the Three-I League team has an old-fashioned wooden grand stand and bleachers into which it is almost impossible to crowd over 4,000 people, and last year on Sundays and holidays the grand stands were completely filled an hour before time for the game to start.

Also the high school athletics of the city draw large crowds, especially the Thanksgiving Day football game between the two largest high schools which is an annual affair attracting the interest of practically the whole citizenship.

In addition to this Terre Haute has two colleges, Rose Polytechnic Institute and the Indiana State Normal which have in the past not had adequate seating capacity for the crowds at their big games.

There is also held annually various exhibitions such as the auto shows, pageant of progress and other manufacturing and agricultural exhibitions which were necessarily held around at various inadequate places because of the lack of a real community building or structure designed for these purposes.

In addition to all of this the citizens of Terre Haute felt that a memorial of some kind in memory of the men and women who served in the world war should be erected. So the Board of Park Commissioners, consisting of the Mayor of the City, the Honorable Ora D. Davis; Mr. Wood Posey, president; Mrs. Conrad Herber, secretary; Mr. Wm. Cronin and Mr. Carl Bauermeister conceived the idea of a municipally-owned memorial stadium which would be the home of professional baseball, boxing, etc., and also be arranged for football, track, tennis and other sports; which would have ample space for fairs and exhibitions and which would comfortably seat any crowd which a city of this size would draw and at the same time serve a fitting memorial to the heroes, both living and dead, who have served the country in the army, navy and marines.

The site is a beautiful wooded area of 55 acres of which the stadium structure itself will occupy 13 acres. This tract has been owned by the county for over a hundred years and it was upon this site that the famous old Terre Haute mile track was located which was the scene of many a thrilling race in the olden days.

The Park Board purchased the site a few years ago from the county for a city park and when the question arose as to the location of the stadium it was the unanimous opinion that this was the ideal place.

The structure itself will be nearly entirely of reinforced concrete construction. The only exception being the main entrance arch which will be built of gray Indiana limestone and the columns and trusses supporting the roof which will be of structural steel. It consists of 21 complete sections; there being expansion joints provided every 64 ft. traversing the complete section of the stand.

The main memorial entrance resembles in design an imposing triumphal arch and will contain inscribed on bronze tablets the name of every man and woman from Terre Haute and Vigo County who rendered service in the war with Germany and Austria.

The structure is unique in that it is the only stadium so far designed to act as a permanent home for the two major sports of football and baseball. In other words, it is a combination design of the usual college or university structure designed primarily for football and of the professional baseball league park of the larger cities.

In addition a full one-quarter mile running track with a 220-yd. straightaway is included in the playing field, and the part of the structure underneath the seat banks will be finished off and will form an ideal place for the holding of the various exhibitions desired, such as farm exhibitions, mercantile displays, auto shows and other city and county activities.

The huge horse shoe shaped stadium structure lies on an axis extending in a northeasterly and southwesterly direction ending in the imposing main entrance memorial arch which faces the southwest corner of the tract but which lies well back in the beautiful wooded park about 500 ft. from the National Highway and will present a striking appearance to the thousands of motor tourists who annually travel this trans-continental highway.

The open end of the horse shoe faces the main line of the St. Louis Division of the Pennsylvania Railroad system, a main traffic artery between the Atlantic seaboard and the central and far west.

The seating capacity is 20,000; arranged for 30 rows of seats topped with a wide promenade extending around the entire horse shoe and with numerous entrance and exit ramps so that the entire stands may be emptied in a very few minutes.

The line of vision of each row of seats

was carefully laid out so that every angle of the entire field is clearly visible from each and every seat.

An idea of the size of the stands will be gained from the fact that the outside wall is over one-quarter mile in length.

A complete roof covers 8,000 seats approximately 1,000 of which are box seats. This provides for the baseball crowd where cover is desirable. All the seats are of wooden construction on top of the concrete. The ones under the roof have backs and all of them are designed for comfort. The most desirable seats for football are not covered as it is generally more satisfactory for this sport to be entirely out in the open. These football seats form the so-called bleacher seats for the baseball diamond.

The baseball field itself is larger than that of any baseball park in the major leagues, except one and the standard football gridiron has seats entirely along each side and around one end.

Boulevard lighting standards extend completely around the promenade. A complete lighting system including flood lights provide for night as well as day time events.

Particular attention has been paid in the design to secure adequate toilet and rest room facilities for both men and women. Also the highest class shower, locker, first aid and team rooms have been provided for each of the contesting teams.

The exhibition space underneath contains over 225 exhibit spaces 16 ft. square amply lighted for daylight use and provided with electric outlets for night use.

A feature of the layout is that entrances to the field from the outside sufficient to admit the largest vehicle or float are provided so that parades or large spectacles such as circuses may be accommodated in the enclosure if desired. Special boxes have been provided for the use of notables who may be the guests of the city.

It is thought that the stadium will be entirely self-supporting from a financial standpoint as well as a very desirable acquisition to the city from a recreational and civic point of view.

The Shourds-Stoner Company of Terre Haute and Chicago were selected as architects and engineers by the Park Board and made a careful study of the existing college, municipal and professional structures of similar nature throughout the country before completing the design. The plans for the stadium and the playing field have been carefully inspected by some of the best known college and university athletic directors who pronounce it all that could be desired in a structure of this type.

The total cost complete will be in the neighborhood of one-half million dollars.

The North Raffin Construction Co. of Terre Haute are the general contractors; Prox and Burget of Terre Haute, plumbing contractors, and the Sanborn Electric Co. of Indianapolis, electrical contractors.

QUESTION RAISED AS TO COST AND VALUE OF POWER AVAILABLE IN PROJECTED ST. LAWRENCE CANAL

(Editor's Note: This magazine strongly favors any proper method of giving ocean-going steamships direct access to the ports on the Great Lakes and has had a sympathetic interest in the St. Lawrence seaway. But, first of all, we favor sound promotion of great projects and the following article deserves consideration because of its discussion of the value, as compared wth the cost, of the power that may be made available in the United States if this project is carried out. Discussion of the assumptions, assertions and conclusions of the article is invited. The article was published by the Buffalo, N. Y., Chamber of Commerce. A subscriber in Buffalo has suggested that it be given the benefit of the wider publicity it receives by its publication here).

There is one statement made uniformly by all advocates of the proposed St. Lawrence Ship Canal which has not been given the attention in the discussion that its importance merits. Broadly stated, it is to this effect:

"No matter what the initial cost of the canal may be, the revenue from power development of the river will furnish ample funds to pay for it."

But no suggestion is offered that any tolls will be charged against the commerce using the canal or that they might be sufficient to pay for that part of the project. Whenever the economic soundness of the canal is questioned, the answer always is that the power users will foot the bill.

It is obvious that this power might be produced without making the river navigable and that the cost of such a power development would be much less than the total cost of the whole canal project with all the additions of locks, canals, dredging, docks and other accessories. So it is

pertinent to inquire how much power there is, to whom it belongs and who the unfortunate users may be who are to be assessed for the cost of a canal that others want to use without cost to themselves.

Available Power

In round figures there is possible in the St. Lawrence between Lake Ontario and Montreal the commercial development of four million horse-power, but of this only about one and one-half million is located on international waters; the other two and a half million being entirely within the Canadian boundary. The report of the joint commission recommends that each country shall pay for the "power works" within its own boundaries so that Canada will own about three and one-quarter million horse-power while the United States will have only three-quarters of a million. But the report also states that since a market wlil have to be developed for the use of this amount of power, the present plan contemplates only the production of the one and a half million on the boundary, half of which belongs to the United States. So that it is really our small share of 750 thousand horse-power toward which our enthusiastic canal advocates are looking as a source of revenue to "pay the bill."

What will be the amount of this bill? The total cost, according to the report, is a sum slightly in excess of 250 million dollars, but this does not include the cost of improving the Welland Canal which is exceeding its original estimate of 50 million dollars, and which is to be included as a part of the cost of the "navigation works" toward which the United States is to contribute its share. And be it noted that our share is not one-half as might be expected, but is such a proportion of the total as our anticipated use of the canal will bear to that of Canada which, according to the report, will be large although no definite figures are given.

So it appears that "the bill" that is accruing against our power users is likely to be about ¾ of the navigation cost of both the Welland and St. Lawrence canals added to the legitimate cost of the power development alone.

Division of Cost

To discuss this matter intelligently, the total cost should properly be divided into three parts as follows:

A. The cost of those features that would be of common use both to power production and to navigation, such as dams.

B. The cost of those features that would be exclusively needed for power development, such as power houses and machinery.

C. The cost of those features that would be exclusively needed for navigation, such as locks, canals and dredging.

The engineer's report does not give the costs of these elements separately, because it is based on the assumption that the canal is of primary importance and power development is a by-product, but a careful analysis of the detailed estimates shows the following division of costs for the three indicated groups as nearly as they can be determined from the description of the items.

A.	$33,487,620
B.	70,776,360
C.	154,489,790
	$258,753,770

In order to allocate the total cost between navigation and power, it would be fair to divide the cost of A equally between these two features of the project which would give the following relative costs of each:

	Navigation	Power
A divided equally	$16,743,810	$16,743,810
B power only		70,776,360
C Navigation only	154,489,790	
	$171,233,600	
Welland Canal, over	50,000,000	
	$221,233,600	$87,520,170

It may be argued that if the power were developed alone, it would have to carry all of the cost of Item A, so that in making a comparison, navigation should only be charged with the additional cost of its features. This would work out the relative costs as follows:

	Navigation	Power
A		$33,487,620
B		70,776,360
C	$154,489,790	
Welland Canal	50,000,000	
	$204,487,790	$104,263,980

The contribution of the United States, assuming that our commerce on the canal is three times that of Canada, would then be in the first case,

¾ of $221,000,000	$165,750,000
½ of 88,000,000	44,000,000
	$209,750,000

Or if the second arrangement were conceded,

¾ of $204,000,000	$153,000,000
½ of 104,000,000	52,000,000
	$205,000,000

In either case, the amount of capital cost for the canal which the power user is to pay for is three times as large as the cost of the power development alone, so that his price for power will carry four times the capital charges that it should.

On the other hand, the Canadian power user will get his ¾ of a million horse-power for a capital charge of half this amount, so that he can export it to us at a handsome profit from this item alone. Nor is that all, because there remains 2½ million more horse-power in the lower river which Canada can develop for an additional sum of $200,000,000, which they can sell to us still more profitably in competition with the exaggerated rate set upon our share of the power in this manner.

For Independent Financing of Navigation and Power Features

In all fairness then, the canal and the power should be financed independently, so that each may be considered on its own merits as a commercial venture. The question of the expediency of the canal project then resolves itself into the question as to whether tolls can be collected from the use of the canal to pay for two-thirds of the total cost of the whole development, and the figures of probable tonnage so far adduced do not offer much encouragement to such a belief. In fact, the very circumstance that the proponents of the project suggest cheerfully loading the entire cost onto the power end indicates pretty clearly that they have no confidence in the economic soundness of this aspect of the scheme.

But it happens that this proposed injustice has a much wider application, because the ¾ million horse-power is a large enough block to exercise a modifying influence on the base price of power throughout the super-power zone. Consequently, if the price of St. Lawrence power is set several times higher than it should be in order to pay for the cost of the whole navigation part of the project, the effect will be felt by every power user east of the Alleghanys, from Niagara Falls to Richmond, and will be reflected in the cost of half of the manufactured goods of the country since that area comprises at least that proportion of the industrial activity of the nation. This point has not been clearly brought home either to the residents of this vast area or to the nation-wide consumer of the goods produced within its limits, else there would be much more active interest in the controversy on the part of the large mass of population who will ultimately have to pay the bill, not through taxes, but in power and light rates forever.

POLITICAL VS. NON-POLITICAL WATER WORKS MANAGEMENT

By R. E. McDonnell of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

There is nothing about the operation or management of a water works plant that justifies any less degree of business sense or judgment than would be demanded of the highest type of business institution.

Because a water plant is owned by the city and the citizens are stockholders is no excuse for ignoring the policy, rules and regulations that apply to any other business institution. Why should political conditions be applied to selling a commodity like water when we know they cannot be applied to selling coal, bread, butter or any other commodity?

How long would our leading merchants, bankers, or manufacturers stay in business if they said to their heads of departments: "Your ability is a secondary consideration, but you must put on our payrolls loyal Democrats or Republicans, put on our friends who helped at election day, put on men who are good ward workers, men who can poll a precinct." Such a policy if applied to any business, except city business, would cause bankruptcy in thirty days.

Why doesn't it cause bankruptcy of a city? Because the citizen stockholders are called upon, by increasing taxes, to take care of increasing deficits.

We are paying the penalty for the curse of partisan politics in city affairs. What a price we are paying because of our classifying ourselves as Democrats and Republicans!

This damnable burden of partisanship hangs like a stone about the neck of many cities. It is a blight more deadly than an epidemic for if it were an epidemic, steps would immediately be taken to remedy the cause.

Community health is the city government's greatest responsibility and it must be protected from petty politics. The purity of a water supply is always an index to the health of a community. The doctors' bills, nurses' bills, hospital bills and drug bills you pay out are a loss to you, but all are necessary because politics cannot give the best of skill for handling those water and health problems.

Water above all other things is the one problem having the greatest bearing upon the health, safety and prosperity of its citizens. Sixty-five per cent of all typhoid is attributed to impure water.

Instead of water improvements preceding the growth of a city they have often lagged behind the general growth and as a result cities will frequently face serious water shortage and many breakdowns before new works can be built.

It may be asked why a political board cannot do the things that ought to be done. There are many reasons:

(1) The water board changes with every administration and these frequent changes prevent any permanent program being adopted. It substitutes a haphazard policy that pleases the powers-that-be.

(2) An engineer ever so efficient and familiar with the operation of the plant is frequently displaced to make room for a friend of the Mayor or of the Board, or of a political boss and the public suffers by such changes.

(3) Even if the political board is made up of the highest type of men, they owe their appointment to the Mayor, and he owes his election to the bosses and, therefore, politics and not ability govern their appointments.

(4) Political jobs where the tenure of office depends upon the vicissitudes of political life, do not attract the high class technical men required for water works construction and operation.

(5) Salaries commensurate with the work and responsibility of technically-trained men cannot be paid by political boards, for fear of criticism. For example, the politicians of San Francisco have been wailing for three years because the Chief Engineer of the Water Department is paid $15,000 per year, a salary higher than the Mayor receives. At Omaha, a city where the Water Department has for ten years been out of politics, the manager is paid $10,000 per year and is worth many times that to the city.

(6) Regardless of the Board's intentions and those of the Mayor, they cannot ignore the organization that placed them there.

A water works plant for any city is valued at about the same or higher value than any of its largest industrial enterprises. This calls for a big broad gauged program; not for two or three years, the life of a political board, but for a lifetime.

Imagine any other business of equal importance in a city that would think of handling its affairs by men selected every two years and because they are right politically. The water question, because of its relation to the health of the community and financial magnitude, demands the biggest brains available and until we do the job commensurate with its importance, some cities will continue to be the laughing stock of other progressive communities.

Frequently business and professional men show a lack of human intelligence when it comes to being led by blind partisanship in city affairs. We go wild every two or four years and follow madly anything with a party label. As long as we continue this we should not complain at paying the price in deficits, in tax increases, in delayed improvements, in high death rates.

FEATURES OF NEW WATER SUPPLY AT PARIS, TEXAS

By John B. Hawley, Consulting Engineer, 403 Cotton Exchange Bldg., Fort Worth, Texas.

Paris, Texas, has a population of somewhere near 20,000. It is a thrifty, prosperous, growing city, surrounded by rich agricultural lands, has five railroads, several maunfacturing plants, and numerous wholesale houses. The streets and alleys are almost universally paved with asphalt of various types; its public buildings are thoroughly modern; its street lighting system is comparable with that of Dallas or Fort Worth. It is not far from the Northeast corner of the State, near the Red River.

ROLLING WETTED EMBANKMENT WITH BANDED ROLLER, PARIS, TEXAS, EARTHEN DAM.

The mean annual rainfall is 38 in, with a minimum of about 18, and maximum of 60 in. Geologically, it lies in the "Eagle Ford Shales," the lowest member of the Upper Cretaceous.

Early in 1920 the writer began a study of water supply matters for Paris, and in the summer called into consultation Mr. Daniel W. Mead, of Madison, Wis., who joined in a report recommending Pine Creek, a tributary of Red River, as the future source of supply. An earthen dam, about 30 ft. high, 3,200 ft. in length, to impound and store the water of Pine Creek, was recommended.

The report outlined also a pumping and filtration plant at the South end of the dam, and a 20 in. cast iron supply main, 4½ miles in length, carrying filtered water to a 500,000 gal. elevated tank near the center of the City. The water level of the tank is 135 ft. above its foundations.

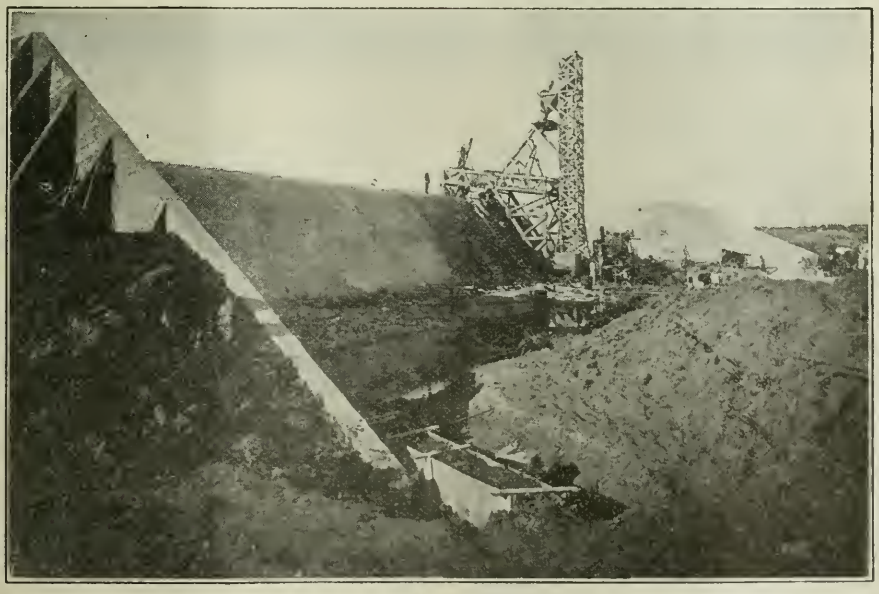
The estimated cost of the entire project, including purchase of inundated lands, was $1,000,000. Upon this estimate, the citizens (almost unanimously) voted a one million dollar bond issue in September 1920.

As the bond market was greatly depressed for more than a year after this, the Mayor and City Council wisely deferred sale until January 1922, when the bonds were sold for par and accured interest. During this "waiting" interval the cost of materials and labor had greatly declined.

END VIEW OF SPILLWAY SECTION, PARIS, TEXAS, DAM.

Plans for all features of the work were developed by the writer, concurred in by Mr. Mead, and construction contracts were awarded in May 1922. The entire works were finished in April, 1923, in time to catch the "Spring rises" of Pine Creek, filling the Lake. Four miles up Pine valley the old "City Lake" impounds about 1,000,000,000 gals. City Lake was nearly empty when the new dam was completed and the new lake filled.

The drainage area of Pine Creek, above the new dam, is approximately 50 square

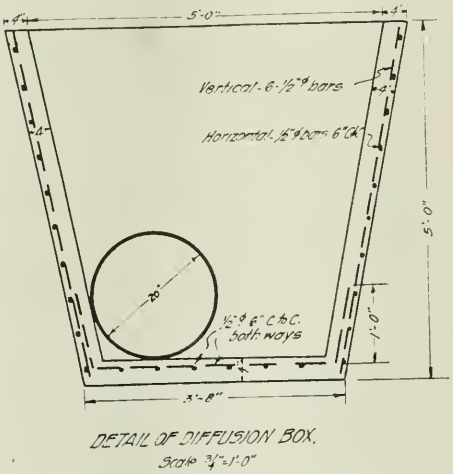


DOWN STREAM SIDE OF SPILLWAY SECTION, PARIS, TEXAS, DAM.

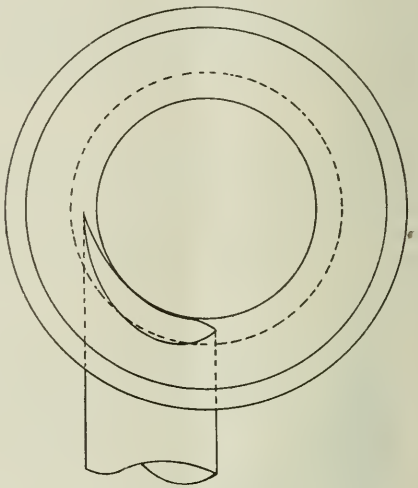
miles. The capacity of lake, all available is 4,000,000,000 U. S. gals. Computation of run off, evaporation, seepage and daily consumption demand, indicate that the two lakes will supply a population of 35,000, at 80 gals. per capita per day, even through a period of six drought years such as 1896 to 1901. The City is 100 percent metered.

The earth section of dam was laid up in 1 ft. horizontal layers, (loose) thoroughly wetted, (about 15 gals. of water per cubic yard) rolled and rerolled with a banded roller that gave compression of 400 lbs. per lin. in. of rear wheels. The material was largely of clayey nature, debris of the Eagle Ford Shales and Blossom Sands.

The water face of the dam was



DETAIL OF DIFFUSION BOX.
Scale 3/4"=1'-0"



DETAILS OF DIFFUSION BOX, PARIS, TEXAS, WATER SEDIMENTATION AND FILTRATION PLANT.

trimmed by removing 1 ft. of "frazzle," perpendicular to slopes, by pick and shovel, laying the reinforceed concrete flags, which are 5 in. thick, constructed "in alternate." The toe of flags abuts on a heavy concrete "footer" for which a 6-ft. horizontal berm was provided.

The photos pretty well illustrate the concrete spillway section and cantilever abutments. The water way is 300 ft. wide and 10 ft. depth.

(These dimensions seem, at first glance, excessive, but were adopted only after long study by Mr. Mead and the writer. See "Public Works" Nov. 13, 1920.) The spillway section and abutments are carried on piling.

The pumping plant comprises three units: One two stage centrifugal, 1050 gals. per minute at 305 ft. dynamic head; one to two stage, 1,400 gals. per minute at 310 ft., both electrically operated and one two stage, 2,000 gals, per minute, at 325 ft. dynamic head, operated by Sterling gasoline engine, as "standby." All pumps have individual, independent suction pipes to clear well, and independent discharge pipes to supply main, which is equipped with recording Venturi meter. Allis Chalmers pumps and motors were used.

The filtration plant is of 3,000,000 gals. daily capacity, four beds of 750,000 gals. each, three of which are fully equipped and the fourth "roughed in," ready for full installation when needed.

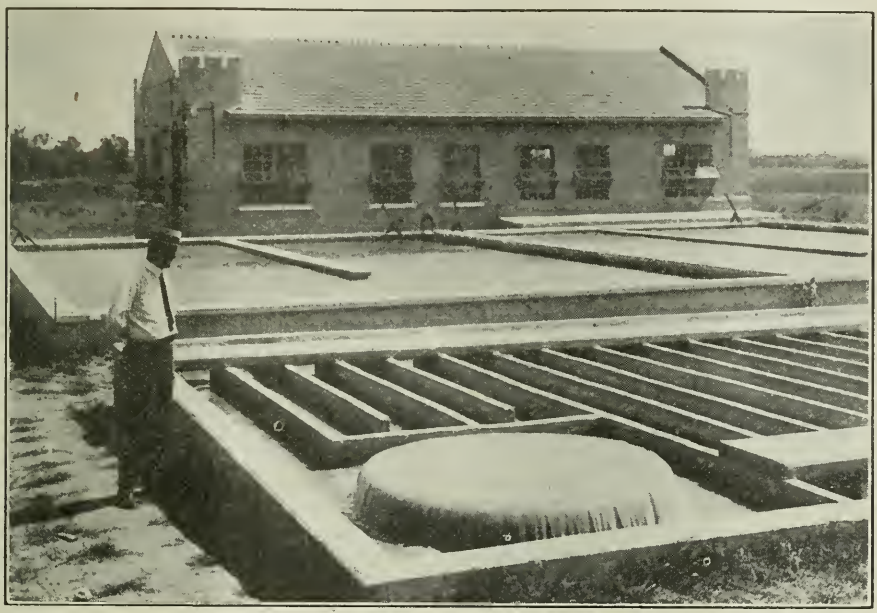
Raw water enters the mixing chambers by gravity, receiving the alum dose at a point near the pumphouse end of the building. The dosed water is given its first diffusion by the "whirl" developed in the inverted truncated cone shown at head of mixing channels, and in the line drawing. The 20-in. raw water pipe enters the bottom of this cone eccentrically. The mixing channels have a length of 1,000 ft.

The filtration plant is of conventional type as a whole, but the well lighted pipe gallery, open to the pump floor, is rather unusual. The circular 400,000 gal. clear well lies to the North of building, and is independent of the latter. Maximum daily pumpage during the summer of 1923 has been 1,200,000 gals.

Under these conditions the labor cost is at a minimum, the lone operative, Mr. Baker, handling both filtration and pumping plant, under the direction of Mr. M. C.

Welborn, Assoc. M. Am. Soc. C. E., City Engineer and Superintendent of Water Works.

The filtered product is tested daily, chemically and bacteriologically, by Mr. Welborn. Algae troubles occured in July, but were quickly abated by mildly dosing the lake with cupric sulphate.



DIFFUSION BOX, MIXING CHANNELS, SEDIMENTATION BASINS, AND FILTER AND PUMP BUILDING OF NEW WATER SUPPLY WORKS AT PARIS, TEXAS.

The entire improvement, including all engineering expenses, cost approximately $800,000, leaving the remainder of bond money for city extensions. City Engineer Welborn had charge of all construction. McGuire and Callender of Kansas City, were the general contractors.

ENGINEERING AND ITS RELATION TO THE COMMUNITY

By Wm. R. Conard, of Conard & Buzby, Consultants and Engineers, Savings Institution Bldg., Burlington, N. J.

The definitions of the words Engineering and Community are given as:

Engineering: The art of designing and superintending the execution of works of a constructive character, such as roads and streets, railroads, bridges, canals, harbors, docks, water works, sewerage works, lighting, power, buildings, and also in the working of metals, and the making of machinery.

Community: Common possession; the body politic; the public; society at large.

At first glance there does not appear to be much in the way of a connection so far as the definitions go between these words so that the task is to establish the relation and of producing sufficient data to prove it.

The conduct or operation of the community functions in at least 7 ways: Organization, co-operation, control, administration, legislation, execution, and regulation, and, by the same token, engineering and the engineer function in the same way at least as the first six.

We have established the relation, and it now becomes necessary to prove that there is an actual connection.

We will take the community functions in the order in which I mention them, and endeavor to show that each is also a function of engineering work.

First, Organization:—The engineer in approaching problems of the community first so organizes his own mind and that of his associates that each phase of the problem stands out by itself and from these in turn are selected the phases of greatest importance then, secondly, thirdly, and so on down the line to minor phases or details.

Second, Co-operation:—After organizing for the problem the next function is to establish the points of contact be-

tween the various phases and then proceed so that each is looking to a common end and the successful solution of the problem as a whole and he thereby gets co-operation.

Third, Control:—After organizing and getting co-operation for the common end, and the complete and successful solution of the problem the function is so to "*control*" the co-operation of the organization that the different phases of the problem advance onward smoothly toward their final answers.

Fourth, Administration; Fifth, Legislation:—These two are so closely allied that the one proves the other. After the answers are found, and the next step in the progress toward the end sought is made, it is necessary to administer the answers and provide the necessary legislation that places the problems on a footing whereby they can be executed.

Sixth, Execution:—The work has been organized, co-operation is obtained, it is being controlled, administering and legislation provided for and the job is now on a proper basis for execution or, to use a more common term, it has reached the active construction stage.

Seventh, Regulation:—After the completion of the job, and it is ready to be turned over from construction to operation it becomes necessary to provide for its careful and regular operation and to that end proper, sane and simple rules of regulation should be adopted, and if these are adhered to there remains no reason why it will not continue to operate with regularity and efficiency.

So much for engineering and now the community.

A community as we understand it today consists in its physical aspects wholly of those things defined as engineering, such as, buildings, roads, streets, water works, sewerage works, lighting, water ways with harbors, docks, canals and bridges, together with such machinery as will construct and operate the various parts that make the whole; in addition to which there must be means of communication either between parts of the community itself and with other communities which naturally makes use of the term railroad or railway, so that almost wholly is any community dependent upon the proper solution of the problems of engineering.

The community also has its problems, of finance, taxation, policing (which is the sane control of its citizenry) legislation, execution of city policies, and co-operation of its people when properly organized. But I submit that by his very training and methods of functioning the engineer is as well qualified to control, administer, legislate, execute and regulate, as any other citizen, and in many instances more efficient than others.

It is because of the close relation of engineering and the community that in the very large majority of cases where our American cities and towns have adopted and are operating under the so-called "Manager" plan of government that the manager is an engineer, for his very training has taught him to: Organize, co-operate, control, administer, legislate, execute and regulate.

THE ARTERIES OF COMMERCE

"More movement, less storage and a better organization of off-rail movement of railroad tonnage," was declared by Mr. J. Rowland Bibbins, engineer and transportation specialist, Washington, D. C., to be the great step in efficiency of the present time, in addressing the recent Chicago Convention of the American Society of Civil Engineers on "The Arteries of Commerce."

What the railroads need is a vacuum pump to pull the freight away from and clear the terminals more promptly and shorten the turn-around of car, ship and truck. This will be the greatest capital saver of the future and simply recognizes that transportation must be considered a through movement, both off and on-rail. It will require a better realization by truckers and industries that railroads have spent probably 50 cts. out of every dollar on other than main line facilities, i. e., on terminals, the "heart" of the system. But the "capillaries" or off-rail distributory system is equally important and the operating costs to the American people are probably as much per year as the total cost of the rail haul. The motor industry has a large problem of organization here in serving both the public and the railroads.

"Growth in values of terminal lands offers perhaps the most hopeful outlook in the development of the near future," said Mr. Bibbins, because of the probability of reclaiming the full values of their lands either by the development of "air-rights" above the tracks for normal business purposes or else by full commercial development, setting back the

terminals to cheaper land areas and using motor-truck delivery. This constitutes a practically unused resource of the railroads in our large cities and will be a two-fold benefit where, as in many cities, railroad terminals are seriously throttling normal expansion of the business center. In fact there seems no other way out of this particular city problem.

Mr. Bibbins presented technical studies of transportation growth since the Civil War, which shows clearly that traffic has increased about as the cube of the population, while fixed physical facilities are probably not increasing even in numerical proportion. This means that the problem of transit through terminals will progressively increase in difficulty unless the "vacuum pump" of speedier motor delivery is applied. His studies indicate that a traffic of four billion revenue tons may be expected by 1940, i. e., a 60 per cent increase, also at least 10 billions new capital for railroads alone if developed on the present system.

But the most striking development pointed out by Mr. Bibbins was that our national transportation plant—rail, water, road, trolley—has cost around 50 billions to date with almost as much—nearly 20 billions—expended for highways and highway transport as for railroads and that in the last decade this new agency has commanded four times as much new capital as railroads. Moreover, if road, water and electric facilities grow only as fast as the railroads, 15 billions more will be required by 1940, or 25 billions total for all transportation. The problem of fitting all these agencies into the whole scheme most efficiently is thus a paramount one before the country.

Another great neglected resource of the railroads was stated to be the joint development of the very valuable entrance rights-of-way into our cities for rapid transit lines and for motor ways in order to save the tremendous costs of parallel right-of-way in subways and trucking thoroughfares which few cities can finance or support.

The necessary difficulties of transport operations in large cities and gateways point definitely, Mr. Bibbins declares, to the great need of proper study and planning for the future as well as the present. And this is a distinctly new development of the wide-spread City Planning movement in which transportation men should be heard. Here is the "heart" of the whole machine, the most sensitive point of control of the life blood of commerce, and every populous community should have a definite transportation plan to guide its future development. The terminals—rail, water, motor and transit —are from the public standpoint all interlinked, and together with the thoroughfare system of the city, constitute the starting point in most effective control of a city's destiny. This has very generally been overlooked in the past and left almost entirely to the whim of competing transport systems. But the tremendous demand of future commerce must and will bring about a change—which may rival even the vastly important matters of consolidation and rates, just now in the ascendancy.

MINNESOTA ENGINEERS IN PUBLIC AFFAIRS

The participation of engineers in public affairs of Minnesota has been a very potent factor in the development of the State, but this participation has generally been limited to promotional work by society groups, for the purpose of bringing about new legislation affecting only engineering projects. In this respect the engineers of the State have been very successful, as may be evidenced by the progress brought about in State laws relating to highways, drainage, sanitation and contracting, and in city ordinances governing city planning, building codes and structural inspection, for all of which the engineering societies have due credit, and it may truthfully be said that they have been primarily responsible for a considerable part of this development.

Until just recently, however, this original work had not been followed up. It has been customary, after the enactment of new engineering policies into law or ordinance and the first flush of enthusiasm has waned, to leave the further necessary legislation and public support to be promoted by those engineers directly affected. Herein lies the opportunity for service by the engineering fraternity as a whole in its relation to public affairs.

It should be a matter of professional principle for all engineers to be well informed on public matters affecting general engineering work and to exert some effort to direct the forming of public sentiment and opinion which really governs administrative policies and legislation. This seems to be the only way to make progress under present conditions for en-

gineers are not generally represented in legislative bodies. The last Minnesota legislature had but one engineer out of a total membership of two hundred, and there was none in the previous season. Very seldom is an engineer to be found in a City Council, and until the engineers do take active interest in political matters we cannot hope for the best results in public work.

Within the last few years there has been a marked development in this State in the participation of engineers in public affairs through the organization of the Minnesota Federation of Architectural and Engineering Societies. This federation of technical organizations can become of great value and service to the community but only through the active help of the individual members. Its Board of Directors has given freely of time and effort successfully to promote and develop public policies affecting engineers' work. We cannot, however, expect the Directors to carry this entire burden but must develop in the individual a consciousness of responsibility for the support of those things which are important to engineers as a whole, even though some such matters have no connection with or bearing on the work of the particular individual in question. The tendency, we find, is to leave too much of this work to our committees and directors; becoming so much engrossed in the details of our own activities that the broader development of engineering practice and influence is retarded through lack of support.

One of the judges of our Supreme Court in a public address recently stated that of the evidence brought out in litigation, that which was offered by engineers was given greater credence than perhaps from any other source as it is recognized that the engineer's testimony and opinion are based upon a careful investigation of facts and a logical application of scientific principles. This statement coming from one who has been on the bench for more than 15 years is food for thought and is an indication of the force which may be exerted by the engineers through concerted well directed effort in matters of public policies. Engineers should not shirk their responsibility through a false idea that politics is not for the professional man. Politics is the science of civil government and would be much the better for the participation in it by engineers.

The foregoing is from a recent address by Mr. John H. Mullen before the Engineers' Society of St. Paul.

VALUABLE TRADE LITERATURE

Electrical Supply Catalog—The Westinghouse Supply Catalog, generally regarded as an encyclopaedia of things electrical is now being distributed. This issue for 1923-24 replaces and supercedes all catalogs issued heretofore on electrical supplies by the Company. In appearance the new catalog does not differ greatly from its predecessor. The former editions have proved so useful and satisfactory that no essential features were altered, the improvements being largely a matter of detail and refinement. Appreciating the importance of accessibility to the specific information wanted, the utmost care was used to meet this requisite. The catalog is indexed according to subjects and to sections, and also has a style number and a thumb index. In addition, a new feature—a classified index—has been added to the introductory section under the title, "How this catalog serves." Here is listed apparatus of particular interest to Central Stations, Electric Railways, Industrial Plants, Mines, Contractor-Dealers, and Architects. The catalog announces the opening of a new plant at Homewood, Pa., which will be devoted exclusively to the manufacture of repairs and renewal parts for Westinghouse apparatus in service but of design no longer strictly standard. A complete list of all Westinghouse Sales offices, Agent Jobbers Warehouses, Service Repair Shops is also given, together with several illustrations of new combination sales, service and warehouse buildings either recently built or now in course of construction. In all, 1,300 pages are devoted to descriptive matter, technical data, dimension drawings, specifications and prices. The material includes all new apparatus developed in the last two years. The street lighting section probably shows the greatest revisions and over 175 pages are devoted to this feature. Close observation shows that the new issue presents a wider variety of apparatus than any catalog heretofore issued by the Company. All sections have been completely revised and some rearranged, which greatly facilitates the ordering of equipment.

Construction News and Equipment

CONSTRUCTING MONOLITHIC CULVERTS IN NORTH CAROLINA TIDEWATER SWAMPS

By I. H. Boggs and C. L. Tindall, Resident Engineers, North Carolina Highway Commission, Raleigh, N. C.

Portions of Projects No. 200 and 201 in Carteret County, N. C., cross tidewater swamps where bridges are unnecessary and where the flow can be accommodated by large culverts. The water in these swamps is salt; consequently, it was thought advisable to build monolithic culverts.

For a long time it has been an accepted fact that salt water is detrimental to concrete. No method of construction nor consistency of mix has yet been found that is guaranteed to competely withstand salt water. It is believed, however, that dense concrete and few if any construction joints will go a long way toward making concrete impervious.

Eleven culverts on the above named projects are under construction in salt marshes. By a special order from the Bridge Department, these culverts are being constructed of Class "A-A" concrete (1:1½:3 mix) and are being poured as a monolithic structure.

The usual way of pouring a concrete culvert—footing first and barrel and headwalls after the footing has set up—is generally known. The monolithic culvert is rather uncommon and the mode of construction may be noted with interest. The general scheme of construction that is employed by the contractor on Projects No. 200 and No. 201 for building monolithic culverts is a combination of ideas of all concerned as no one on either project had ever seen a monolithic culvert built.

Unfortunately, there is not a stable foundation in any of the salt marshes. First, therefore, it is necessary to drive bearing piles to carry the load. Incidentally, these piles are of great assistance in the construction of a timber floor which has to be built under the entire footing of all the culverts.

The footing of an ordinary culvert, where conditions demand, may be floored with pine slabs or other cheap lumber, then the footing poured and allowed to set up before the rest of the structure is completed. The footings of these monolithic culverts, however, must be floored with timber of sufficient bearing capacity to support the weight of the entire structure until the concrete sets up and the load is transferred directly on the piles.

After the piles are driven, the excavation is shaped up and carried to an extra depth of about 8 ins. to admit the floor stringers which are spiked to the piles. The floor is built with rough timbers the size of which varies with the span of the culvert. The floor under the barrel is made sufficiently wide to permit the sidewall forms to rest on it.

The entire set of forms for the culvert is built in place on the floor. The outside forms for the wall are braced to poles that are driven securely in the mud 8 or 10 ft. from the structure. The inside or box form is built in sections and then set on the floor and bolted together on the inside. The box form is supported above the floor a distance equal to the thickness of the floor-slab by 1x2-in. strips that are nailed to the studding inside the form. (When the box form is removed from the completed culvert, these 1x2-in. strips are knocked loose from the studding and cut off flush with the floor-slab.) Planks for the top of the box, or that part which supports the top-slab of the culvert, are cut and fitted but not put in place until the footing and half the wall have been poured. Access to the footing while the concrete is being poured is thus permitted.

The steel for the footing is wired together in mats and laid on the floor before the barrel form is set in. It is supported in its proper position by being laid on precast concrete blocks or suspended by wires from the stringers in the box form. This steel is best supported by the concrete blocks. The blocks become completely imbedded in concrete, whereas, wire can be cut off only at the surface of the slab thus permitting an attack for salt water.

Steel for the top slab is wired together,

usually in two mats, and laid in the wet concrete after a 3-in. layer has been poured on the top of the box.

Suspension of the steel in the walls offers no particular difficulty if the brace-wires running through the walls are so placed that they coincide with the horizontal steel. The horizontal steel may be fastened to the brace-wires and the vertical steel in turn fastened to the horizontal.

After the forms are completed and the steel is in place, the greater part of the job is done. Pouring the concrete is comparatively simple and means nothing more than a good, long day's work. With ample material at the mixer, a good supply of fresh water, and an early morning start, an 8x4-ft. culvert is completed in twelve hours with a one-bag mixer. In cool or moderately, warm weather the footing may be poured throughout the entire length of the culvert before a layer in the walls is started, but, if the weather is hot, care must be taken to add a shallow layer of concrete in the walls as the footing progresses. If this layer is not added, the first concrete poured in the footing will have obtained its initial set before the footing is completed and the wall started.

Rubbing of exposed surfaces to remove board marks left by the forms is not permitted. It is believed that concrete is more impervious when the surface is not disturbed by rubbing. A good finish is obtained by first oiling the forms well before the concrete is poured and then tapping the forms lightly with a hammer as the concrete is placed to assure a film of mortar next to the forms.

It may be said that monolithic culverts are no more difficult to build than ordinary culverts. They are more expensive, however, because of the necessity of building a strong timber floor, the extra work in suspending the steel and numerous other extra details.

Great care in every detail is being maintained in the culverts. Only time will tell whether or not monolithic construction is going to lengthen the life of these structures in salt water.

The foregoing description is from the North Carolina Highway Bulletin.

OLD AND NEW TRAFFIC COUNTS ON BROADWAY COMPARED

To the Editor:

Your note, in the issue of June, 1923, quoting figures of traffic on Broadway at Chambers Street in 1852 is very interesting when compared with recent traffic counts. The figures quoted give a total of 15,648 vehicles for 13 hours.

Police records give 10,300 vehicles passing Broadway and Fulton Street in 1915 and 9,565 in 1919, during the 10 hours from 8:30 a. m. to 6:30 p. m. These include east and west, as well as north and south traffic, but do not include street cars.

Correcting the figures of 1852 traffic to a 10-hour day would give 12,040 vehicles, still considerably more than the present-day traffic.

The traffic on Broadway at Fulton Street, a few blocks south, would be in 1852, and is now, practically the same as at Chambers Street.

R. A. MacGREGOR,
Member Am. Soc. C. E., 1709 Popham Ave., New York, N. Y.

STEADY PAVING BRICK PRODUCTION

Continued steady production of vitrified paving brick indicates a healthy business condition in the industry, and continued active brick street and road construction work during the balance of the season.

The July statistical report covering 68 percent of the normal tonnage capacity of the industry, just issued by the National Paving Brick Manufacturers' Association, shows production and shipments keeping pace with those of previous months.

Production for July was 30,529,000 and shipments 27,092,000 compared with production during June of 31,105,000 and shipments of 27,251,000. Stock on hand of 78,835,000 brick is reported.

July shipments were made into 30 states and Canada, with Ohio leading in consumption followed by Illinois, Texas, Iowa and Pennsylvania in the order named.

JUDICIAL DECISION DEFINES LOWEST RESPONSIBLE BIDDER

Throwing light on the discretion that may be exercised by public boards in awarding a contract on competitive bids, under a statutory requirement for an award to the lowest responsible bidder, the Pennsylvania Supreme Court said in

This street in York Village, Maine, was first treated with Tarvia in 1913.

A macadam road brought up to date. Main Street, Le Roy, New York—transformed by Tarvia during 1919 and 1920.

Columbia Avenue, Vandergrift, Pa., once an old brick street, was surfaced with Tarvia in 1914.

The Three Ages of Main Street—

What are the three ages of America's Main Streets? First, the Age of Mud and Dust—the age of the sprinkling cart—the age when spring thaws turned Main Street into a mud-hole.

Next, the Age of Incompleteness. In this period, a few blocks of Main Street were given a fine, expensive pavement. Then came an abrupt break-off into unimproved country roads.

And today—the Age of Tarvia.

Main Street has been extended. Instead of short stretches of ultra-expensive pavement, the public now demands the greatest possible mileage of good roads that the available funds will permit.

To meet this demand, experienced road officials are constructing moderate priced, low maintenance Tarvia Roads. Moreover by the use of Tarvia they are transforming at small expense worn-out macadam into modern "all-year" highways.

Tarvia roads are not only firm, smooth, dustless and mudless all the year round, they are far less costly to build and maintain than any other type of modern highway. There is a grade of Tarvia for every road purpose—new construction, reconstruction, repairs and maintenance.

If you will write to our nearest office we will promptly and gladly give you practical cooperation in solving your road problems.

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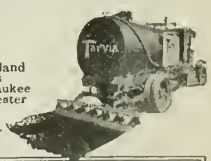


State Street, Hart, Michigan, first treated with Tarvia in 1913.

the late case of Hibbs v. Arensberg, 119 Atlantic Reporter, 727:

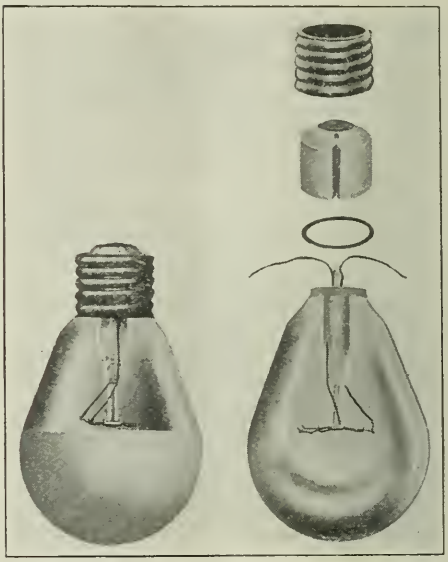
"The term 'lowest responsible bidder' does not mean the lowest bidder in dollars; nor does it mean the board may capriciously select a higher bidder regardless of responsibility or cost. What the law requires is the exercise of a sound discretion by the directors. They should call to their assistance the means of information at hand to form an intelligent judgment. They should investigate the bidders to learn their financial standing, reputation, experience, resources, facilities, judgment, and efficiency as builders. This was not done. The Court below censures the board for omitting this important step, but it holds, inasmuch as they had ample knowledge of the successful bidder and the merit of its work, the contract could be awarded. This might do in private affairs, but will not pass when public funds are at stake; it is not the exercise of discretion. Though the directors were not bound in law to give the contract to the lowest bidder, who might be irresponsible, they were bound to investigate, and if a bidder measured up to the law's requirement as a responsible party, the board could not capriciously award the contract to another. Giving a bond alone does not make up for responsibility; we have too many bonding companies willing to indemnify almost anything. But there should be a sufficient reason, where a bidder is lowest and responsible, why the job was not given to him. And where such reason appears, the action of the board is generally conclusive."

KULP THEFT-PROOF ELECTRIC BULB

It is estimated that from 15 to 30% of the electric light bulbs used by railroads, industrial plants, hotels, apartment houses, ships, schools, theatres, stores and public places of all kinds, are stolen. One railroad claims a loss of over $13,000 annually; another shows figures of over 3,000 lamps vanished in ten months; a hotel association finds that over a million bulbs are stolen annually from its members.

And this loss in dollars, tremendous as it seems, is said to be actually doubled by the cost in time and labor to make replacements. There is, too, the loss of work due to lack of light, and the ever-present danger of accidents in dark places, from which lamps have been removed. In some locations as in hotels, heavy current using utensils are connected to lamp sockets, frequently burning out fuses, and whole circuits, with attendant fire risk and cost of repairs.

The new Kulp Theft-Proof Bulb, designed to prevent all such loss and danger, is just being placed on the market by Lester Kulp, 143 W. Austin Ave., Chicago. The remarkable simplicity of the idea particularly recommends it, as there are no guards, locks, keys, springs, or other mechanisms. It is a standard lamp in every way, that fits into any standard socket—complete in itself and looks and is



THEKULP THEFT-PROOF ELECTRIC BULB.

used exactly the same as an ordinary lamp. And more important still, it carries no extra cost for theft protection, for it is planned to sell this bulb at regular standard prices.

The illustration shows how these unusual advantages are obtained. One contact is at the top just as in ordinary lamp. The other contact is a brass ring, fastened at the bottom of a porcelain plug. This plug has a groove which is filled with plaster of paris, lightly holding the brass shell in place. After the lamp is screwed into the socket, an extra turn breaks the plaster of paris seal, so that the lamp can turn freely in the shell, always maintaining electrical contact. The shell, however, cannot be turned in the socket. The shell being spun over

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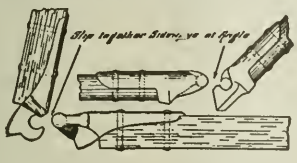

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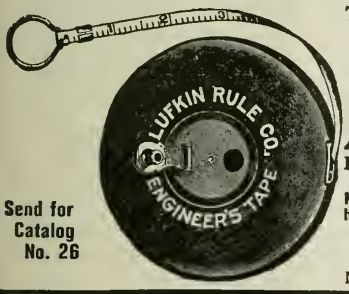

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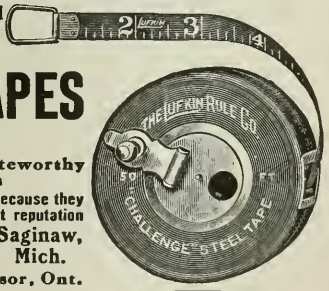

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the ring, screws up so close to the socket that fingers or tools cannot grasp it. Thus the lamp positively cannot be stolen or even broken in the attempt to steal it, thus preventing endangering circuits.

When the bulb is burned out, it can easily be removed for replacement. The bulbs come in any standard size, voltage or wattage.

USING DYNAMITE IN MOSQUITO ERADICATION

Dynamite is one of the latest agents to be employed extensively in the war against mosquitoes. It has been used in many places in Virginia to blast ditches throughout mosquito-infested swamps and lowlands to drain out the breeding places of the pests. Experts of the United States Health Service have used it repeatedly. It has been employed in Alabama in municipal mosquito control work, in Arkansas, Texas, Florida and in other states. The control of the explosive is such at the present time that the experts can blow a ditch as desired. By employing it in certain amounts, placing it at certain depths and in certain lines, they can make the ditch shallow or deep, wide or narrow. One of the interesting methods is to shoot dynamite by the propagated method, as it is called. In this use, one dynamite cartridge detonates another, so that by placing a cap in one, the entire row of cartridges, placed at intervals, and sometimes extending for the distance of a mile, can be exploded by the one charge from a blasting machine.

Engineers in various parts of the South have found dynamite especially valuable for ditching under adverse conditions where there were trees, stumps, heavy bushes, or other obstructions in the right of way. Under ordinary conditions with hand labor or with dredges, the right of way would have to be cleared before the actual operation of ditch digging began, but with dynamite, all the obstructions are blown out together with the earth, so that a great deal of time and labor are saved.

Another feature of dynamite when used for ditch blasting is that it leaves no spoil banks to drain back into the ditch. It blows the dirt into the air and scatters it around on the landscapes. The engineers of the Virginia State Board of Health found that under certain conditions they could cut the cost of ditching 50 per cent by using the explosive. Farmers in Northern New York found that the cost of digging ditches by dynamite was 20 cts. less per rod than by the hand method. Plantation engineers in Florida found that they could reduce the costs of ditching from 25 to 50 percent by using the explosive. In many places where there is a shortage of hand labor, or costs of labor are high, dynamite has proved to be the most economical agent, besides being far more efficient.

The mosquito has to face an aroused public opinion. Health officers say that he must go. They say that with sufficient men and money they can always eradicate him. With the reports coming in on dynamite as an efficient anti-mosquio agent, it seems entirely possible that proper drainage can be so widely carried on as to bring the pest under complete control.

WORK OF THE PLAYGROUND AND RECREATION ASSOCIATION

The Playground and Recreation Association of America, with its 17 years of experience, is ready to help cities and towns with their recreation problems. It exists only for service and is non-political, non-commercial and non-sectarian. The Association offers four major lines of help as follows:

1. Through literature, much of which can be had free of charge.
2. Through counsel by correspondence.
3. Through co-operation in getting through legislation for clearing the road to municipalities that really want to do something in this field.
4. Through the field staff, available for consultation, recreation surveying, community recreation program making, and practical promotion.

Mr. Eugene T. Lies, Special Representative, 21 N. La Salle St., Chicago, is available for speaking appointments before important civic, educational, religious and technical bodies interested in community projects.

EDITORIALS

COMPETITIVE BIDDING BETWEEN ENGINEERS

Recently, in these columns, we stated our editorial policy with respect to competitive bidding between engineers by saying, in substance, that in our opinion the practice of asking consulting engineers to bid against each other for a piece of work is bad and should be discouraged. We still hold to that view, but the subject is so important that it merits full discussion. The present discussion is inspired by a friend who has a disconcerting faculty for putting his finger on the fallacy in an argument. He is inclined to favor competitive bidding between engineers as the natural and proper way for the deserving younger men to get jobs. Before discussing this particular phase of the matter it may perhaps be desirable to state more fully why we are opposed to the practice.

It is not so much the element of competition in the bidding that is objectionable as it is the nature of the bidding and the attendant circumstances. On many, perhaps most, jobs where a consultant is to be called in, there is some competition; proposals are asked from two or more engineers. This, however, is done quietly and somewhat informally without advertising the job and inviting everybody and his brother to come in and join in a competitive bidding contest in hammering down the price. If a city council asks a firm of engineers to name a figure for a certain job, the engineers are likely to set a price that will enable them to do a good job for the city at a profit for themselves. Under such circumstances the engineer in fixing his price will feel that he is the only one asked to name a figure, or is one of a very few, so he is inclined to keep his fee up to a proper standard. But where the job is widely advertised and, as stated, brought to the attention of every engineer, the price any man asks is very likely to be substantially lower than it should be. In fact there would seem to be no argument necessary to show that the very purpose of open competitive bidding is to hammer down the price. This practice might be justified if fees were generally too high, but they are not. Now since the object of open bidding is to keep fees low, and as this object is attained, we condemn the practice because the fees are thereby forced down to the point where the successful bidder either cannot do a good piece of work or cannot make a profit from his work. It seems this is a condition as bad for the public as it is for the engineer.

Probably the one thing most injurious to the welfare of the engineer is the popular notion that one engineer is as good as another and that once any engineer is employed at any price he can and will, by some mysterious process, do all that could be expected of him. Open competitive bidding is an expression of this fallacious belief; this seems sufficient reason for condemning it. Money saved on an engineer's fee is often very expensive money.

Now with all due respect to the great engineers of the country we do not believe that they should get all the work. As a matter of fact they do not get it all. Younger men should have their chance to establish themselves and they do have that chance and always have had it, without recourse to open competitive bidding. In fact the better class of rising young engineers will establish itself more quickly without competitive bidding than with it. The man who intends to do an honest and skillful piece of work is at a distinct disadvantage in open competition with the man who expects to do a shady piece of work in a slip-shod manner.

There are various ways for the young consultant to get business without plunging into the whirlpool of open competitive bidding. He can build up confidence in his integrity and ability by becoming acquainted with those in position to employ him. Naturally most of his early opportunities will be close to him where he is best known. He will learn of opportunities in nearby places and can then present his claims for consideration in a dignified way by letter or by personal interview. We believe most young consultants who have achieved success have started in this way.

THE ENGINEER AND UTILITY OWNERSHIP

Probably a large majority of engineers favor private ownership of public utilities; at any rate, that is the impression gained from many years of discussion of this subject with engineers in all parts of the country. It is interesting to consider the reasons for this and to inquire whether or not the engineer is likely to change his mind on this subject.

The conditions of employment under both private and public ownership are well understood by engineers. Generally speaking, the rewards paid to those who make a success under private ownership are greater than are paid to those who serve equally well under public ownership. Again, the man who makes good under private ownership is likely to hold his job as long as he wants it, while the man who makes good under public ownership may lose his job at any time it serves the purpose of his superiors to turn him out. These are the fundamental reasons for the preference of the engineer in respect to utility ownership, and they are good reasons, easily understood.

Looking under the surface, however, one is impressed with the fact that the engineer's reaction in the premises is merely that of the servant who appreciates good pay and steady work. If the engineer exercised the qualities of a master would he still prefer private ownership?

Under private ownership the large reward goes to the capital invested, if the utility is prosperous. Under public ownership, where service rather than profit is the end sought, the large reward should go to management, although it does not now go to management as a rule. But it is likely that when the engineer finally asserts himself and goes before the public with the statement that he is best qualified to make a utility produce maximum service at minimum cost, but that he will demand adequate compensation for doing so, he will be better off under public ownership. Until he is ready to fulfill his destiny, in this field, he will do well to continue his preference for private ownership. The editor hopes to be on the side-lines, leading the cheering, when the engineer announces the end of his period of apprenticeship and claims his reward.

REGULATING PARKING OF AUTOMOBILES

An exceptionally interesting article on the parking of automobiles is published in this issue. This article is so good that the man who set the type and the lady who read the proof both spoke to the editor about it. This is the perfect tribute and may be regarded as the attainment of the ultimate in praise.

We do not wish to do more here than to call attention to Mr. Ihlder's remarkably interesting and helpful discussion of one of the most difficult problems of our day. The officials of almost every city are now struggling with this problem and every reader is sure to derive benefit from the article, no matter what part he plays in the game of traffic regulation, whether he regulates or is regulated.

DISTRICT HEATING

We have been pleased to present to the readers of this magazine several good articles on district heating. More such articles are wanted and engineers and city and utility officials who have had experience in this line are especially urged and invited to contribute to the discussion of this important and timely subject. A valued correspondent calls our attention to the need for greater uniformity in the terminology of this subject. He states that he has often wondered why reference to the matter of heating a group of buildings, either by steam or water, from one plant is not referred to always by the same term. Some say "central station heating" or "community heating," while others prefer "block heating" or "group heating," and still others prefer "district heating." The latter term has much to recommend it. For instance, over ten years ago a national association was formed by the various companies selling heat and the name decided upon for this organization was the "National District Heating Association." It is felt that District Heating is the best term to designate the heating of several buildings from one heating plant and the term will be so employed henceforth in this journal.

COMPLETE RECONSTRUCTION OF DOWN TOWN STREETS OF SPRINGFIELD, ILL.

By Wade D. Seeley, City Engineer, Springfield, Ill.

The City of Springfield, Illinois, has taken quite a stride in the last few years in the development of her streets. Somewhere between 25 and 60 per cent of the entire built-up area of the average American city is in its streets; and in them is to be found one-third (in value) of all its property also. Every citizen is dependent, in his business, and his very existence, upon the streets, the traffic on them and the conduits under them. Consequently mistakes made in the laying out or original construction of a city's streets entail on all its citizens unnecessary discomfort and expense for all time.

Original Pavements

The first paving laid in Springfield was during the year 1878 when cedar blocks were laid on hemlock planks 2 ins. thick. Various grades of wood were used and several miles of the main streets were paved with red cedar laid on oak planks up until 1886. During the year 1887 the first brick pavement was laid for an experiment and it was judged superior in every respect to white cedar blocks.

Various changes in the paving specifications were made in later years and during the years of 1892 to 1895 the main streets and the entire business district were repaved with the most modern brick pavement at that time. (Two course work or brick on edge set on brick laid flatwise). These pavements have resisted the wear of traffic for 28 years, and in places where the pavement has not been disturbed for underground construction, are still in fair shape.

Need for Reconstruction

In the last few years, this city, like most cities and towns which were planned before the motor made its appearance, commenced to grapple with its traffic problems, and with the fact that an adequate street plan may cost large amounts. It must be borne in mind that the outlay today will be less than it will be two or five years hence. Our Chamber of Commerce and Civic Leagues have recognized the fact that any poorly paved city will drop back, and those streets and sections which are not applying the remedies are certain to fall into more or less disuse, with corresponding reduction in property values.

Survey

The city commissioners, attorneys and engineers held a conference and laid plans for the big improvement program. The first move was to prepare an exact survey of all underground structures in the streets. Plats were drawn to a large scale and the maze of pipes and conduits under the pavements was shown.

Ornamental Street Lighting

The first improvement made was an ornamental street lighting system covering the entire business district to be improved. Nearly 400 standards were set, and care was used in alignment as regarding future widening of streets. The improvement was made under the Special Assessment Act, and the cost covering the same was spread over a period of three years.

Heating Mains

New steam and hot water mains were next installed. The latest materials for heating mains were used, and great progress was made in constructing the work during the short period the heating mains were shut off for the summer months. One circuit of the main artery of the heating system leading from the Central Power Plant for a distance of eight blocks cost over $250,000 and was constructed in three months.

All electric wires owned by public utilities and the City were placed in separate conduits, and all electric transformers were installed in large concrete manholes, placed out of the street under the sidewalks.

Water and Gas Mains

The cast iron water mains and lead service pipes were all renewed and in some places enlarged. Six inch cast iron water mains were replaced with 16 in. mains, and the fire hydrants were enlarged and re-set, affording a more adaptable place in fighting fires.

The gas mains were also enlarged and service pipes leading to various buildings were renewed.

Sewerage

In the midst of all the tearing up, the sewers were not overlooked. On some streets new sanitary sewers were laid to a depth of 18 ft. and house connections of either 12 or 8 in. sewer pipe were provided for each parcel of land along the improvement.

Street Railway Reconstruction

After all the underground structures were completed, or carried on in advance, the Street Railway Company work was

started on the tracks and carried on both night and day. The old tracks of light rails and hand-mixed concrete laid in 1903 were ripped up from one end to the other. New intersections, typifying the best in modern methods, were used of manganese steel wieghing 127 lbs. to the yard. Some intersections, 100 pieces of curves, frogs, switches, crosses and straight tracks were completed at a cost of $29,000.

Several different methods of track construction were used. The roadbed was first drained with a 6 in. field tile. Upon this a 6 in. Portland cement concrete slab was laid according to the formula of 1 part Portland cement, 4 of washed gravel and 2½ parts of sand. Crushed stone ballast was laid on the concrete slab and the ties were concreted in place. Several thousand feet of tracks were laid by placing 4 ins. of crushed stone upon a tiled roadbed and concreting the ties in place, using the same formula for the Portland cement concrete. Then, again, the rails were brought to proper grade by using wooden block under the ties while the concrete was poured around the ties and tamped in place.

Car Track Paving

Granite blocks, 3½ ins. in depth were substituted for rail bricks and the balance of the tracks were paved with 3½ in. vitrified paving brick laid flatwise. The interstices of the brick were filled with an asphalt filler. Cast iron track drains were used at the necessary places and electric switches were included in the work.

While the track laying was in progress, steam shovels were removing the subgrade in preparation for the paving work.

Street Widening

The old stone curbing was removed and the street widened to a width of 48 to 64 ft. Care was used in having each particular street widened to a uniform width, but in a few cases it was impossible to follow this rule. All corners were enlarged to 16 ft. radius, except at intersections near fire engine houses, where 22 ft. was used. All storm water inlets were trapped to the main sewers and direct connections were made to the nearest sewer and manholes were placed over the inlet pipe at convenient places.

A Portland cement concrete curb was used having a thickness of 6 ins., except at street corners, where a thickness of 8 ins. was placed to receive the greater wear.

All excavations were thoroughly flooded with water, and in most cases where deep excavations were encountered the flooding was carried out several times, to insure a solid roadbed. A light 3 to 5-ton roller was first used before the heavy 10-ton roller completed this work.

Washed gravel and sand were trucked to the concrete mixer and the cement was added at the machine.

Upon the main streets having the major portion of excavations in the underground work, 8 ins. of Portland cement concrete was used, having a 1 to 7 mix. In the balance of the streets 6 in. foundations were used.

Brick Paving

The paving bricks of 3½ in. depth were laid flatwise and an asphalt filler was squeegeed over the whole surface and a light top dressing of sharp fine sand was used.

The original plan for this local improvement was outlined to cover a period of four years. Two years have now elapsed and the work has been carried on like clock work. Weather conditions have caused more delay this year than last, but the excessive rains have helped settle the earth excavations.

Some Car Tracks Discarded

In order to clear the streets of unnecessary street car tracks without seriously hampering trolley service, 13 blocks of car tracks were abandoned.

In the central portion of the City the streets improved around the Lincoln Square were widened 12 ft. by extending the paved portion of the street to the building line. The sidewalks were constructed inside the lot, and adjacent to the curb line. It was thus planned that ample space would be available for vehicle parking place. Two sides of Lincoln Square have now been completed, and the streets have been opened to travel. The 12 ft. space has been properly utilized and has greatly helped in handling traffic in this congested district.

Balance Between Street and Sidewalk Width

Some question has arisen as to the proper width that should be allowed for walk space for pedestrians. Some 48 ft. paved portions of streets are now planned to be widened 4 ft. on each side, so as to leave 12 ft. of space on each side of the street. The members of the city council have passed on the question that 12 ft. is sufficient for a walk space. Some merchants claim that excessive widening of

streets should not be permitted, and that the city officials should have as much consideration for pedestrians who use the sidewalks by the thousands as for the vehicles which use the roadway by the hundreds.

It is a great question, but we have planned to help conditions that exist today. The cost has run into large amounts as over $250,000 was expended last year for paving in the down town district, and the cost will run about the same amount for this year.

ROAD AND PAVEMENT DRAINAGE A NECESSARY ECONOMIC INVESTMENT

By J. W. Howard, C. E., E. M., Consulting and Testing Engineer on Roads and Pavements, 1 Broadway, New York, N. Y.

Increasing attention is being given to proper drainage of the subsoil under and adjacent to roads and pavements. Every portion of the location of a pavement or road must be studied by a competent engineer to determine in advance of construction or improvement the portions which will have to be properly drained by permanent installations underground and water which does the damage either as a sometimes otherwise in order to prevent water from being the prime cause of injury, if not destruction of the road or pavement. In 1902 the writer stated, in an article entitled "Pavements Injured by Water," that "the principal cause of injury to many pavements and roads is water which does the damage either as a liquid, or by freezing. It makes it possible for traffic to do great damage by the water first softening or loosening a pavement. Traffic of vehicles, which a casual observer thinks does the most damage, is of itself less injurious than water. A pavement once uneven from moisture or frost is easily and rapidly further spoiled by traffic. Pavements laid and maintained so that water can do them little harm are very slowly affected by traffic. * * * A well laid pavement requires a subsoil drained naturally or artificially. Water below a pavement or road undermines or softens the subsoil, causing settlements. It freezes and forces up irregularities in the surface. Water often works up through concrete foundations and gathers in various ways on its upper side, thus getting between the foundation and the stone, brick, asphalt, etc., pavement surface layers. Water thus displaces, disintegrates and weakens the entire structure. A solid, dry and compact subsoil is needed for all roadways."

Although more roads and pavements are being properly drained than heretofore, nevertheless, there is great laxity almost everywhere in this respect. This is especially true on streets and roads which have no curbs or protective edgings and other means of preventing water seeping from outside underneath the pavement; especially during periods of heavy rains.

Proper permanent drainage installations costing relatively little, constitute an insurance for the permanence of a road and its pavement and guarantees the ultimate economy of the entire capital invested in the subgrade and foundation; also indirectly, in the wearing surface layer of whatever material it may be on the surface of the street or road. The permanent surface layers of many materials can be economically maintained in constant good condition indefinitely by a little attention from time to time provided the road or pavement has a good foundation and proper lateral and subsoil drainage.

Some of the injuries from water are from the following causes: (1) Insufficient drainage from side ditches; (2) level of the road foundation and surface too little above surrounding country, so that during extremely wet weather, water seeps under the pavement; (3) failure to provide culverts, blind or other cross drains under the pavement to carry water to the side drains or ditches; (4) wherever a road extends along the side or the base of hill, special drains are needed to provide for disposing of spring and underground water on the uphill side of the road and sometimes on the downhill side of the road. If ditches are used on the uphill side, they must be well outside the roadway shoulders and to a sufficient depth below the bottom of the base of the pavement to convey the water to culverts or elsewhere. Subsurface drains at a depth of at least 3 ft., filled with broken stone or large gravel, lengthwise the road and connected with similar drains crosswise the road, are suitable and inexpensive for many locations. The cross drains under the road should be spaced at short intervals of, say, 50 ft., and at longer intervals where the local conditions permit. (5) In some cases where it is believed subsurface water or

seepage from the sides will get under the pavement, it has been doubtful practice to construct blind drains under the center line of the road. Such construction needs many lateral blind drains or other outlets to prevent the center drain from becoming clogged in time and retaining water, which softens the subsoil. In cold climates such water freezes and dislocates the pavement above. It is seldom necessary to provide longitudinal drainage under a road. The same length of drains under the center of the road will provide an ample number of cross drains to fulfill the same function.

Several states have set a good example by preparing plans and specifications for every kind or classification of drainage, the necessity for which can be foreseen; also providing for such additional drainage as may be found necessary during actual construction; prices to be bid upon being per lineal foot in accordance with the plans and specifications for the various kinds and quantities of drains as estimated will be needed; there being a further provision that any extra drainage construction will be furnished, where necessary and ordered in writing, at cost of labor and materials plus 15 per cent. This practically means at cost, because overhead charges of supervision, etc., are not included.

Professor F. H. Eno, of the Engineering Department, Ohio State University, made the following interesting statements in an address he gave at a Convention of the American Road Builders' Association: "(1) There is seldom a paved road which does not provide perfect (surface) cross drainage, at least from the center of the road to the edge of the paved area. Beyond that point, perfection in drainage is difficult of attainment. (2) A perfectly stable, dry, well-compacted soil is necessary to support roads subject to heavy traffic. (3) D. S. Humphrey, of the Ohio State Highway Advisory Board, says that most of the highway engineers are making a serious mistake in cutting through the top soil for their subgrades. If, instead of quibbling about grades, they would build their road foundations on top of the subsoil, they would get very much better support for their roads and at the same time secure better drainage. (4) One argument for placing roads on top of the soil is the fact that greater opportunity for leading surface water away through culverts is provided. It also permits shallower ditches and more fall to the outlets. (5) Advantage should be taken of natural soil drainage by building the road on top of the original soil as far as possible. Minimize the cuts. Multiply the culverts. Conduct the water away from the road into natural channels as frequently as possible."

EFFECTS OF CHANGING AIR TEMPERATURE AND MOISTURE CONTENT ON BEHAVIOR OF PAVEMENT SLABS

By H. W. Skidmore, Consulting Engineer, Chicago Paving Laboratory, 160 N. Wells St., Chicago, Ill.

I have just read the article entitled, "A Different Angle on the Subdrainage of Pavements," contributed to the September number of Municipal and County Engineering by Monroe L. Patzig, and note that he invites discussion of this subject.

The term "moisture expansion" is prominent in the article, and it appears that the author considers this a most likely cause of blow-ups, joint heaves, difference in elevation of slab ends, curling of slabs and other defects common to rigid pavements, particularly Portland cement concrete.

The effect of moisture content in Portland cement concrete is pretty definitely known, and if this were the only factor seriously concerned with the behavior of the pavement slab, it would be a relatively simple matter to design the slab, under the various conditions prevailing in each individual case with respect to moisture, so that the pavement would not suffer directly from this source. Eliminating frost heaving, the defects referred to in the article are manifestations of structural weakness that occur, almost entirely in the hot weather. The effect of changing air temperature is rapidly reflected in the behavior of the slab, whereas, expansion due to an increase of moisture requires long periods of time to assume serious proportions, and the contraction due to evaporation of moisture is even slower.

A situation might be imagined where a slab constructed in dry weather upon a dry subgrade was later subjected to high moisture content for a period of several months. Sufficient stress might be accumulated to cause joint heavage or even actual rupture, and still under especially advantageous conditions some curling of the slab. But the extreme con-

ditions that would be required to accomplish any very serious results from this source are so uncommon that in ordinary practice moisture expansion or contraction will usually require only passing consideration. The exception to this rule is the surface checking due to rapid evaporation of moisture during the setting period; and the seriousness of this defect can be largely, if not entirely, eliminated by proper curing.

Moisture content of the soil, however, is very frequently a most serious factor with respect to the load-supporting power of the subgrade. Its effect varies widely among different soils, not only in separate localities, but even within the limits of a relatively small project. The result may be either to increase or decrease the supporting ability of the soil, depending upon the nature of the soil and the amount of moisture present. Some soils increase their supporting power by absorbing moisture up to a certain optimum amount; this value decreasing when the percentage of moisture is either raised or lowered. Probable moisture content during the cold season must be given serious consideration, because of the possibility of frost heaving and the consequent rupture of the pavement structure.

Decidedly the most serious aspect of the moisture question is its relation to the variability of the load supporting power of the subgrade. It is generally conceded that some drainage must be provided. This usually takes the form of side ditches or drains on highway work and curb and gutter, with or without drains, on city pavements; constructed longitudinally of the pavement in order to intercept and divert, at least the bulk of the water that would otherwise have access to the soil and cause excessive moisture content. In many cases, no doubt, drainage structures have not been entirely adequate. Yet, on the other hand, there are great areas, especially in the middle states, where the soil is of such nature that even elaborate systems of under-drains in addition to the usual provisions for removal of surface water have proven of very little, if any, value in reducing the moisture content of the soil below an amount that seems fairly constant from season to season, and is considerably in excess of that which would render the soil anything like par with respect to supporting value, when compared with other soils. The Bates Road Tests have rather clearly demonstrated this fact. Obviously, there is one solution in such cases that will unquestionably provide a permanently stable support. That is the construction of a sub-foundation or subgrade of gravel, broken stone, etc., not primarily for the purpose of providing drainage but to supply the required under-support. The situation will, without doubt, be met with some such solution as soon as it is found that in the long run it will prove to be more economical than attempting to build a rigid slab equal to the situation in all respects.

Relative to the curling action of concrete slab, Mr. Patzig says:

"* * * But with moisture expansion there is a decided tendency for the concrete slabs to curl upwards due to the greater expansion on the lower surface than on the upper one.

"This curling action can be more pronounced in concrete pavements than on concrete base under other types of pavement surfaces, because there can be greater differences between the moisture or humidity of the two surfaces."

It must be taken that he refers, in the second paragraph above, to the under side of the slab in both cases. And if so it would appear that there is a discrepancy in the statement. Providing both types, that is an uncovered Portland cement concrete and, say, an asphalt surface on Portland cement concrete base, existed under the same soil and moisture conditions, and the air temperature at the surface in both cases was the same; he apparently means to say that the curling would be greater in the case of the uncovered concrete because the moisture or humidity would be greater on the underside of that slab than would be the case with the concrete base slab. There would seem to be absolutely no reason for such an assumption. In fact, if there was any difference at all, the reverse would be true, owing to the much lower rate of surface evaporation in the case of the moisture-proof asphalt top. This theory will not account for the fact that uncovered Portland cement concrete slabs curl and warp more than those that are topped with another type of wearing surface. The reason is that in the case of asphalt top, we have an insulating blanket, which not only greatly reduces the rate of temperature penetration, but also prevents the rapid evaporation of moisture.

Portland cement concrete pavement slabs curl up at the edges at night, due

to the fact that the upper surface is rapidly cooling off and is in the process of contraction, whereas, the bottom of the slab, not being in direct contact with the air tends to retain its heat and consequently does not assume the same rate or degree of contraction as the upper side. Conversely, during the heat of the day, the slab is warped in the other direction, often lifting free from the subgrade at the center. This is, of course, due to the fact that the top surface is expanding much more rapidly than the bottom. The whole performance simply illustrates the effect of changing air temperature in developing varying stresses in the structure. It occurs much too rapidly to be due to moisture expansion.

During expansion the slab between joints may be said to be in compression, with the force acting longtitudinally through the slab. The construction joint is almost inevitably a weak section, consequently most of the heaves come there. If the joint is perfect, there is no joint at all, and the rupture will search out the weakest section elsewhere. The raising of one slab end above that of its neighbor may be due to one or more of several causes, e. g. There might be a slight difference in subgrade elevation; the joint may not be perpendicular to the plane of the subgrade; one slab may be a little stronger than the other, or of slightly greater thickness. Perfect joints rather than drainage would seem to be the answer to this defect.

There is now available a vast amount of data relative to the various items mentioned in Mr. Patzig's discussion. There is much more in the making. This will unquestionably result in better pavements. But it still is a big question whether truly rigid types will ever be reduced to that exactness which will render them entirely satisfactory and wholly economical under all conditions.

FACTS AND FIGURES ON COMMUNITY OR GROUP HEATING

By H. C. Kimbrough, American District Steam Co., 712 First National Bank Bldg., Chicago, Ill.

The subject of group or block heating, and the application of the principles of community or group heating in cities large and small, have led to a desire to ascertain the smallest devisible unit of operation which can be successful commercially. For this purpose a detailed investigation of the engineering and commercial factors was promulgated, and I am indebted to Mr. Walter J. Kline, of the American District Steam Company, for his engineering study of this very interesting problem of group or community heating.

The chosen field for observation included two well built residential blocks in a city on the lakes, comparable in every way with districts in Cleveland, and in this report were discussed all of the items involved in the inception, organization, design, construction and operation of a district heating proposition, confined within the limits of a community or block plan; the most important of these items being:

(1) Proper selection of block or district; (2) Volume of space to be heated; (3) Amount of heat required based upon recorded data for similar latitude; (4) Design and cost of proper boiler plant; (5) Discussion of return system and cost; (6) Method of operation, meters, etc.; (7) Cost of operation; (8) Fixed, depreciation and maintenance charges; (9) Revenue to be paid by members of the community; (10) Surplus to be paid to participating shareholders.

The original study included a number of items which have been checked and revised as a result of conference and discussions, as well as a review and checking by other engineers and individuals who were interested.

(1) By running a single steam main with long services, instead of a "loop" with short services, it was found that the cost is reduced somewhat and these figures are used in the estimate herewith.

(2) The value of the water plus the value of the heat in the condensate is insufficient to justify the required investment in return mains.

(3) An ornamental stack can be constructed which will be sufficiently attractive to be proof against reasonable objections. It will add to the cost at least $1,000, which has been included in the revised figures.

(4) In a study of a community or district heating plant, in St. Louis, the idea was proposed of building a community garage with capacity for 15 cars, in which would be located the boilers, likewise room for storage of coal. On the second floor it was proposed to equip an apartment for the man who would be in charge of the garage and the firing of these boilers. Such a building would cost

roughly $25,000 to $30,000 and the rent of garage space would more than provide interest and return on the combined community boiler plant and garage.

(5) From the figures we have eliminated all items of "customer's house piping."

(6) We have eliminated "interest" from the cost of operation.

(7) The item of "coal cost" has been reviewed from the standing of assumed evaporation "steam delivered" to customer on efficiency of operation. Oil burning is out of the question at this time, because of the cost of oil.

(8) It is quite evident that clerical labor, superintendent, fitter, etc., if charged to a single block, will result in a disproportionate overhead. The same organization can look after many blocks, and therein lies the desirability of including ALL the desirable blocks in a district rather than a restricted community. The matter of depreciation and maintenance has been reviewed and is established for the purpose of this analysis as follows:

Insurance and taxes, 2 per cent of the total; depreciation, 4 per cent of the total; maintenance, general, 2 per cent of the total; maintenance, boilers, $2 per h. p. per year.

The following, then, is the statement of cost of construction and operation of a single unit, or block plant. It consists of 42 residences, 4 apartment buildings, one club and nine garages, aggregating 3,630,000 cu. ft. of space, which will require an annual average of 38,090,500 lbs. of steam condensed in radiators and house piping. Based upon an evaporation of 6¾ lbs. of water per pound of coal and an "efficiency of delivery" of 85 per cent, there will be metered 5¾ lbs. of steam per 1 lb. of bituminous coal burned, or approximately 3,300 tons.

The foregoing results are based upon 100 per cent of the existing buildings participating in the community, or block plan of heating, and it becomes at once apparent that the greatest possible "load" should be secured to insure the maximum return on the investment.

Hundreds of community heating plants may be installed throughout the country on the co-operative participating plan, and made self-sustaining, with a fair return on the cost, and providing for upkeep and renewals.

Financially the desirability of pooling the cost of installation and operation of many individual boiler plants, and constructing and operating one central plant, is evident. Why not do away with the annoyances of getting coal, handling ashes, and depending upon irresponsible attendants? Why not have one smoke stack instead of a multitude? Why not enjoy a clean community free from the smoke nuisance and its damage to property and furnishings?

A very worth while item to consider in the presentation of community or district heating is the avoidance of coal storage, in advance of the heating season. The unloading of coal in the basement of the individual house represents a very considerable tying up of money which earns nothing during the winter season.

From the standpoint of the consulting engineer, the cost of a plant or production should not weigh against the desirability of community heating service. The countless community centers in which there are six, ten, a dozen or twenty property owners, whose chief concern is the comfort of dependable heating service and who are able and willing to pay a reasonable charge for the privilege—would be the consulting engineers' field for development of community heating

INVESTMENT AND OPERATION

Cost of 300 H. P. Boiler Plant and Stack		$36,000
Cost of Steam Distribution System (including Trenching)		38,000
Cost of Meters and Valves		3,750
Total cost of Construction		$77,750
Cost of coal—$6 per ton	$19,800	
Cost of teaming coal and ashes	3,300	
Depreciation, Maintenance, Insurance and Taxes—(8%)	6,210	
Maintenance Boilers, etc., $2 per H. P.	600	
Cost of Water	500	
2 Firemen—8 Months	$2,240	
1 Chief—12 Months	1,800	
1 Meter Man and Clerk	800	
Miscellaneous Expense	250	$5,090
Total Operating, Fixed and Labor charges		$35,510
Income from 38,090,500 lbs. of steam if sold at sliding scale of rate, approximately $1.31 per Thousand pounds (coal $6.50 teamed to power plant) total sales		$49,898
Operating Charges, forward		35,510
Surplus over operating		$14,388
Percentage on Investment, ($77,750) 18.5%		

plants. Every building having at present a heating boiler has a potential beginning of an argument for a community or block plant, because the longer the owner operates this separate unit, with its separate upkeep, labor and annoyance, the more certain is the possibility of interesting him in "buying his heat" from a central community plant, through properly installed underground heating mains; just as has come to be the custom of having water through pipe, gas through pipe, and electricity by transmission into the house, apartment or business building.

We have "backed away" from this very interesting study and development long enough, it would seem, and it is clearly a wide and almost unexplored field of substantial return to the consulting engineer, and his collaborator, the architect.

THE FIRST YEAR OF MUNICIPAL OWNERSHIP OF DETROIT STREET RAILWAY SYSTEM.

By Lent D. Upson, Director, Detroit Bureau of Governmental Research, Detroit, Mich.

(Editor's Note: The results of the experiment in municipal ownership of street railways in Detroit are being carefully watched throughout the country. Many reports both of success and failure to date have been circulated. The present article by Mr. Upson, reprinted here from the National Municipal Review, gives the facts on which the reader can base his own opinion of the merits in this controversy.)

On May 15, 1923, Detroit completed its first year of municipal ownership and operation of a unified street railway system. On this occasion Mayor Frank E. Doremus gave a statement to the press that the system had earned in excess of $1,000,000 during that year. This statement has attracted comment and criticism from two principal sources—first organized and unorganized anti-municipal ownership propaganda which deliberately misinterprets the facts presented; second, from conscientious citizens who want to be convinced that municipal operations have been more successful than private.

Municipal operations in Detroit may be judged by two criteria—financial results and service. It has not been seriously contended that the service under municipal ownership has been worse than under private ownership—probably it has been better—and the storm has raged principally about financial results.

The Financial Record

The municipal street railway system is a unification of 61½ miles of work constructed by the City, and 312 miles purchased from the Detroit United Railways, giving a total mileage of 373½. Outstanding against the system are $19,000,000 in 30-year bonds and a $17,000,000 purchase contract that must be liquidated in 10 years—all such debt charges as well as operating charges and taxes to be paid from earnings. The rate of fare is 5 cts., with 1 ct. for a transfer, giving an average rate of slightly less than 5 1/3 cts. The real financial issue is whether the department of street railways must earn enough not only to liquidate debt charges in excess of $2,000,000 a year, but also to create a depreciation fund sufficient to maintain the plant at present value. It is very questionable whether at the present rate of fare, the municipal railway can meet both charges completely. If, as is contended by some, municipal ownership, to be a success, must meet both charges, probably the discussion need go no further.

However, there is presumably some argument against this contention. No privately owned utility is required to retire its funded debt from earnings. It is questionable whether any public utility commission would permit a rate sufficient for such retirement in addition to providing for depreciation. The Detroit charter does not specifically require that both charges shall be met completely. The charter states that sufficient debt, in the discretion of the board of street railway commissioners, shall be retired so that the system be eventually paid for out of earnings. It is only circumstance that nearly one-half of the system must be paid for within ten years. The drawing upon a depreciation fund for money to pay this debt practically results in refunding it over a longer period of years.

The financial statement for 11½ months' operation substantially in the form submitted by the department of street railways, is as follows:

Operating revenues		$19,067,631.30
Deduct:		
Operating exp.	$13,368,796.72	
Taxes, rent, etc...	634,641.15	
Interest	1,795,487.07	
Sink. fund charges	2,238,070.73	
		18,036,995.67
Net profit carried to surplus		$1,030,635.63

A more practical manner of reporting

would take a form usual in privately owned utilities:

Operating revenues		$19,067,631.30
Deduct:		
Operating exp.	$13,368,796.72	
Taxes, rent, etc.	634,641.15	
Interest	1,795,487.07	
Depreciation	2,000,000.00	
		17,798,924.94
Net profits or surplus available for debt retirement or other purposes		$1,268,706.36

In other words, were this a private utility, it would actually have met all of its depreciation charges and other operating expenses including interest, and had a balance of $1,268,000 as profit. The depreciation is an estimate. It may be more than $2,000,000 a year, but it is probably less. This rate is figured at 5 per cent on $40,000,000 for the entire year and on assets of every character. This profit of $1,270,000 is available for the retirement of debt and represents the increased equity of the City in the system. This is certainly a substantial conformance with the charter requirement that the plant be acquired eventually out of earnings. The creation of a depreciation reserve which would actually indicate the lessening value of assets through wear and tear would in no way affect the amount of cash available for the retirement of debt, which requirements are in excess of $2,000,000.

Service Statistics

Service is not so easily appraised, being subject to as many a priori judgments as there are car riders. In a statistical way, however, it is worth while to note that in May, 1922, there were 1,530 cars in operation with an average monthly mileage of 3,500,000. One year later there were 1,616 cars in operation with an average monthly mileage of 4,271,000. The increase in total number of passengers was from 36,700,000 to 41,700,000. Approximately 500 of the City's cars were new, among them being 175 of the Peter Witt type.

Correlative to service is the subject of maintenance. It has been charged that the department of street railways has spent an inadequate sum on the maintenance of way, overhead and equipment. What constitutes adequate maintenance is too disputatious a subject for consideration here. It must be borne in mind that Detroit purchased so depreciated a system that it was freely predicted that uninterrupted service could not be continued. In June, 1922, one car broke down for every 2,000 car miles operated and trolley breaks totaled nearly 300 for one month, and for an average of five months were never less than 200 per month. In April, 1923, break-down of cars had been reduced to one for every 5,000 car miles operated and trolley wire breaks reduced to about 90 per month. This latter is the result of stringing 60 new miles of copper and repairing and replacing about one-third of the entire system.

Street paving continues in bad repair. The D. U. R. over a period of three years immediately prior to acquisition by Detroit, spent an average of $185,000 a year on paving over an urban and interurban system totaling 800 miles. In approximately one year the city of Detroit has spent in excess of $200,000 on an urban system of 373½ miles. It is estimated that the rehabilitation of the City's lines and equipment will cost between $5,000,000 and $6,000,000. Such rehabilitation might properly be charged to capital. Since capital is not available, it must be done from earnings, which means that the criticism of tracks and pavements in bad repair will continue for some years to come. Obviously, the system cannot accomplish a complete rehabilitation in one year. Nor can service be largely improved until some satisfactory plan of rerouting or underground dips is established. At present 18 of the 27 car lines center at the city hall, and during rush hours 700 cars per hour pass this point. There is a physical limit to the number of cars that can be operated on a given piece of track during a given time, no matter what the demand for service may be.

The Detroit Bureau of Governmental Research has just concluded a study of the finances of the department of street railways for the period of 11½ months that has elapsed since May 15, 1922, the date of the unification of the system. This report endeavors to deal in an unbiased way with the actual financial facts as indicated by the records of the department of street railways. Copies will be sent to any who may be interested, upon request, and such readers may draw their own conclusions as to whether or not municipal ownership in Detroit has been a success.

Detroit Should Succeed

From the writer's point of view, however, there is no particular reason why municipal ownership should not be a success in this instance. The plant was bought at probably only a part of its true

value and the outstanding debt against it is presumably very much less than would be the liabilities of a private corporation. The system, at least for the present, is free from politics; has had available a certain amount of capital for improvements; has operated during a year of unusual prosperity and has had competent direction, many of the operating heads having held similar positions with the private corporation. On the other hand, there is no particular reason for believing that private ownership, under similar conditions, would not have done as well. Unhappily, there is a feeling abroad in the land that the results of municipal ownership in Detroit are going to affect vividly the municipal ownership of utilities in many municipalities and have a bearing upon the nationalization of steam railroads. In consequence, the critics of governmental ownership have ascribed all sorts of derelictions to the Detroit experiment and the friends of municipal ownership have discovered untold virtues. Success for one year in Detroit does not insure permanent success, or insure similar results for other cities.

The Detroit Bureau of Governmental Research has made just one general conclusion from its examination of the complex financial problem confronting the department of street railways and that is that under the circumstances, creditable progress has been made. Aside from this one conclusion the Bureau has presented only facts, believing with James Madison, "That a popular government without popular information or a means of acquiring it, is but a prologue to a farce or a tragedy."

SELECTION OF TYPES OF ASPHALT PAVEMENTS WITH REFERENCE TO LOCAL MATERIALS

By Roy M. Green, Manager, Western Laboratories, Lincoln, Nebraska.

Importance of Street Pavement Problem

During the year 1921 over $120,000,000 was expended for the improvement of the streets in the 252 largest cities in the United States. During the same year the sum of $34,742,791 was expended for sanitation and the promotion of cleanliness, and $55,396,376 for schools in the same cities.

Over 39 per cent of all the outlay of funds in these cities was expended for highway improvement. More than twice as much was spent for street improvement as for schools and nearly four times as much for street improvement as for sanitation. These statistics indicate the relative magnitude of the street paving problem as compared with other municipal undertakings on the basis of financial importance.

Regardless of the manifest importance of this problem in every city in the United States we still find the laymen of the various cities, through their city councils, or commissions, feel justified in taking from the hands of their engineers the important problem of the selection of the type of pavement to be used in any location. The success of the street system, as a transportation medium, is entirely dependent upon this selection, yet many members of city councils feel themselves qualified to select the type of pavement to be used. These same men would hesitate to even make a recommendation regarding the design of a sewer or water-supply system, where much less money is involved in the enterprise.

Authority of Engineer

Although it is manifestly a fact that this authority should be vested in the engineer we are still confronted with the condition, in many states, where the law delegates this authority to the city council, or even worse, to the abutting property owners within the district to be paved. Without any question, this reacts against the best interests of the public and results in improper selections in many instances, and is one of the greatest contributing causes of the short average life of pavements.

Since the engineer does not have this authority it would seem, at first thought, that a discussion of the selection of types of asphalt pavements with reference to local materials is a waste of time at a meeting of engineers, but this is not true.

Even though the engineer is confronted with this condition he still has great authority in making the selection of type through the fact that he still has practically unlimited authority in the drafting of the specifications for the work contemplated. Let us call this, selection of type by specifications. Unfortunately the engineer too often overlooks the fact that he has this authority and hastily draws up his specifications by simply adopting the standard specifications of one of the national agencies that have adopted such standards, never realizing that his client may suffer great financial loss through such procedure.

There is never a locality where one of the asphalt pavement types does not have a superior economic advantage over all other asphalt types on account of the availability of some source, or sources, of supply of local materials. In some cases these local materials may be of such a nature that they will not meet the requirements of the specifications of the American Society for Municipal Improvements or of the Asphalt Association. I do not wish to be understood, however, as criticising these specifications, because I most heartily approve of them, and especially those of the Asphalt Association, which I consider as the best group of standard specifications that have ever been prepared, but I do wish to bring out the fact that the blind use of standard specifications is poor engineering and results, in many cases, in higher costs to the owner without a corresponding improvement in the quality of the finished product. On the other hand, it is likewise very poor engineering to specify for the use of local materials without first making a very thorough investigation of these materials. Furthermore, such an investigation should not simply include the usual laboratory tests of these materials but should embrace a thorough examination of the deposits, method of production, quantity and uniformity as well as quality of the material itself. These investigations should be carried on only by persons who are thoroughly qualified, through years of experience in the construction of asphalt pavements, for if they are not, the entire expenditure of the owners' money is then being placed upon an experimental basis, which is a condition never justifiable under any circumstances.

If this procedure is followed it will be possible for the engineer to exercise great influence in the selection of type with reference to local materials if he makes a thorough investigation of the availability of materials of all kinds and then makes sure to include in his specifications a description of the type that can be constructed by using the greatest quantity of low priced material of a quality that is entirely satisfactory for the purpose intended. As soon as bids are received under these specifications the price bid on this type should be low enough to make the selection almost inevitable.

Abuse of Selection by Specification

Allow me to take two illustrations from cases that have come to my attention in our practice. In one city an engineer asked for bids upon sheet asphalt and asphaltic concrete, coarse aggregate type. The specifications for the large aggregate for the asphaltic concrete allowed the use of a very inferior grade of broken stone and as a result an aggregate was used having a toughness of only four when treated by the Page Impact Machine. To have obtained satisfactory large aggregate of broken stone for this work would have required its being shipped for a distance of over 500 miles and from another state at a very high freight rate.

On the other hand the large aggregate for use in the binder course of the sheet asphalt was described in such a way that it required an aggregate of a toughness of 10 and a French coefficient of wear of not less than eight and made it necessary to ship this material a distance of over 500 miles, while there were good commercial deposits of gravel containing materials that would have been entirely satisfactory for that purpose within a distance of less than 50 miles. All other aggregates entering into the construction of the sheet asphalt pavement were even nearer than this with the exception of the stone dust for filler. The engineer either abused the privilege of selection by specifications and deceived the owners' confidence and wasted their money or he was ignorant. In this case, I believe that it was the former, because he specified also that the binder for the sheet asphalt should contain 7 per cent of limestone dust. The city is no longer a client of the engineer.

Proper Use of Selection by Specification

Let us consider another illustration, where specifications were drawn with the intention of utilizing available materials to the greatest advantage. The city, through their engineer, adopted a specification, which incidentally is not in accordance with any of the standard specifications for large aggregate for binder construction, but is good practice and has been demonstrated as being satisfactory for the work contemplated. Through the use of these specifications, instead of the adoption of one of the standard specifications, the most economical selection was apparent to any unprejudiced party and resulted in the saving of approximately $50,000 on a two-year paving program and the quality of the work did not suffer in the least

detail. All the aggregates for this work were obtained within 5 miles of the improvement with the exception of the limestone filler.

In closing, however, I wish again to sound a word of warning against the adoption of any local materials or special specifications unless their adoption is thoroughly investigated by one who is unquestionably qualified to pass judgment upon their utilization for the work contemplated as it would be a serious error in policy to place the expenditure of public money, in such great quantities, upon an experimental basis and it would react against the best interests of all concerned in the construction of roads and pavements. I wish to draw attention to the economic value of making thorough investigations of all sources of supply of materials for utilization in the construction of asphalt pavements.

The foregoing paper was read by Mr. Green at the recent Asphalt Convention held in Denver, Colo.

REGULATING THE PARKING OF AUTOMOBILES

By John Ihlder, Manager, Civic Development Department, Chamber of Commerce of the U. S., Washington, D. C.

A few years ago automobile salesmen talked about the saturation point in terms of the public's buying power. They calculated the possible number of automobiles in a state by the number of families with a certain income. Today such figures, except as applies to the rural population, are going into the discard. The saturation point for automobiles is coming to be the incapacity of streets, not only in cities, but even in towns and villages, to hold more cars.

Experiments With Moving Traffic

A year ago we talked of regulation in terms of moving traffic. The traffic cop had become a familiar sight even to the most untraveled American. We exercised our ingenuity to devise methods of expediting traffic by rules and signals and no left turns and one-way streets. We even devised high towers which would halt the moving lines of cars for blocks when the light switched from green to red. Then the law of diminishing returns got in its deadly work and we today see the long lines halted on a busy main traffic artery blocks away from the signal tower when there are no vehicles waiting on the little-used cross street. Then we tried speeding up the traffic, and, turning our animosity from the fast driver, leveled our imprecations at the cautious one who slowed up the line, until actual count showed us that increasing the speed beyond a certain limit means no more cars passing a given point in a given time than does a slower movement—for the simple reason that each driver leaves a little more space between his car and that in front.

What to Do With the Standing Car?

Now we have suddenly awakened to the fact that this interesting game of regulating moving traffic, while the more dramatic, is not the more important part of our problem after all. The more important part is to find out what to do with automobiles, not when they are moving, but when they are standing still. Until some inventive genius invents a collapsible car that can be folded up and put into the hall closet or a corner of the office, this question of what to do with an automobile when it is not in use is going to cause more and more concern to manufacturers and salesmen and to would-be owners, than ever has been caused by justices of the peace with a keen eye for local revenues.

Some Abandon Driving to Work

Of course we have been making tentative and superficial efforts to answer this question for some time, but with results so unsatisfactory that in the largest cities car owners have given up the attempt to drive to their offices near the center, and even in moderate sized towns the merchants, the police and the car-owning public are most dissatisfied with these results and with each other. Curtailment of parking privileges along business streets to periods limited from a brief stop to discharge passengers to a two-hour stay, unless supplemented by constructive measures, are only expedients which give some relief at considerable cost and annoyance.

Is the Automobile a Nuisance?

So recent is our realization of this problem that there are regulatory authorities who still approach it from the point of view that the automobile owner is more or less of a nuisance who should be thankful for whatever facilities are grudingly granted him, and some traffic experts who maintain that inasmuch as two or three riders in an automobile take up more space in a city street than do several times that number in trolley

cars or subway trains, therefore the answer is to limit more and more strictly the use of automobiles in downtown areas, perhaps confining it to taxi-cabs which, being more constantly in use, serve a greater number of passengers and call for only a fraction of the parking space.

Effects of Rapid Rail Transit Cited

Of course such a solution as this is no solution, but is rather a method of intensifying conditions that make for further overcrowding of our already overcrowded business and apartment house areas. The result would be the same as that which followed the building of elevated railroads in New York and Chicago and later that of subways in New York. Both were acclaimed as means of spreading out the population, for was it not obvious that workers in downtown districts could by these means afford to live farther out? Of course what followed was the exact reverse; those who lived farther out did more business downtown and conditions instead of being bettered became much worse. Not only did business buildings increase in size to accommodate the new hordes of workers, but high apartment and tenement houses with constantly smaller and fewer rooms per apartment closely encircled the business districts because a large proportion of the workers found that the time, expense and discomfort of twice daily journeys by rapid transit were such a handicap that uncomfortable housing seemed to them the lesser of two evils. The way out is *not* by devising methods of compressing human beings into smaller compass, but by devising means of living and doing business comfortably and economically.

The Present and Future Problems

When one comes to study the problem from this point of view he finds that it divides itself into two parts: First, the immediate problem of what to do now under existing conditions to get the utmost practical value out of the automobile with the least possible cost and inconvenience to the community; second, how to guide the future development of our cities and towns so that this modern means of transit may be more and more generally used to the increasing benefit of all the community.

What the Shriners Taught Washington, D. C.

There still remains in some quarters the belief that the passenger automobile is primarily a pleasure vehicle. Even if it were, there is a strong argument for facilitating its use. But we had a recent demonstration in Washington of the falsity of this notion, at least so far as concerns their parking on business streets. We have had the Shriners with us. During the days of their visit they nearly doubled the population of the City. Prophecies were that they would bring with them at least 30,000 automobiles. We were impressed by the probable difficulties of handling so large a number of visitors and in order to make space for them our rulers—you know that we who live in the District of Columbia are not citizens except by courtesy, for we have no vote and no voice in our government—our rulers, the District Commissioners, decided to put a ban on parked automobiles in the central business district and fortunately decided to put this ban into effect a week before the Shriners' convention opened. I say "fortunately," for this edict gave us a fact which otherwise would have remained a theory. On the day the ban went into effect the downtown stores were empty of customers. The long aisles between heaped up counters were deserted. Trolley cars operated as usual and to capacity. But the automobile shoppers, chiefly the drivers of the cheaper cars who do not support chauffeurs, were absent, and their absence made so startling an effect that by noon a hastily assembled committee waited upon the commissioners and successfully petitioned that the ban be lifted. The automobile has become a necessity of modern life and our task is to devise methods of utilizing it, not to follow an ostrich-like policy of ignoring its value.

The Motor Vehicle a Modern Necessity

The means immediately available for dealing with the standing automobile are limited and, as indicated before, are largely in the nature of more or less unsatisfactory expedients. The first requisite is to approach the problem from the point of view that the automobile, passenger car as well as delivery truck, is a necessity of modern life and that our purpose is to facilitate its use. The degree in which various expedients may be used will vary in different cities and towns according to local conditions. There are, however, some generalizations which may be used as guides. First, the streets are designed primarily for transit. Consequently they must be

kept free from standing vehicles to the extent necessary for an even, uninterrupted flow of traffic. Second, the entrances to hotels, office buildings, large stores and other buildings in which there is a great amount of coming and going must be kept accessible. Third, so far as is consistent with the foregoing, car owners should be permitted to park their cars on the public streets or other public space in front of or close to their destination and leave the cars there all day if they so desire.

The third generalization is, of course, an ideal and as with ideals can be only more or less approximated. Even in small country towns there are periods, as on Saturday evenings during warm weather, when the whole area of Main street in the business section will not accommodate the cars of all the farmers who come in to town. Consequently an effort must be made to provide convenient supplementary parking space. But no other space will be more than a second choice substitute for the curb in the middle of the principal business block where the car owner and his wife not only have the shortest carry from store door to car and can have their children constantly in sight, but where, when seated in their car, they feel almost a part of the holiday crowd from which they can call out passing acquaintances and hold a series of informal receptions. In larger towns and cities only a fraction of those who wish it can secure this ideal parking. But that is no reason why those who come first should not be served first so long as this does not interfere with traffic or access to much-frequented buildings.

Time Limit Expedients

Between this all-day parking and the stop to discharge passengers before a hotel, there are gradations in time limits, the value of which is still largely theoretical. Whether a 15-minute parking limit is, as a rule, of practical use, may be questioned. For the man who reads your gas meter this would be ample. Perhaps it should suffice for the life insurance agent. But it is not enough for the woman who is buying material for a new set of curtains or for the family dinner. Perhaps we shall come to a simple threefold classification of parking spaces on business streets; stop to discharge passengers, shopping stops which may extend from 15 minutes to two hours, and all-day parking.

But with all the time limit expedients we can devise our streets in the business districts and in many apartment house districts are now inadequate to contain all the cars whose owners wish to park them there. Supplementary parking space must be provided.

Using Vacant and Idle Spaces

In towns and cities where there are considerable areas near the business section—but not with valuable business frontage—still unbuilt upon, the municipality should acquire these and maintain them for automobile parking. It may charge car owners a small fee for this service on the principle that it charges users of city water, or it may give the accommodation free on the principle that it permits free use of the sewers, to take care of what might otherwise become a public nuisance such, for example, as the "cruising" of automobiles, including taxi-cabs which have no parking space.

In nearly all cities, large as well as small, there are considerable areas in the centers of blocks, even in downtown districts, now disused or wastefully and uneconomically used. So long as these block centers remain in private ownership they are a constant temptation to the erection of deep, solid buildings, the lighting and ventilation of which is difficult and expensive. There is an economical height for a store or office building. Where blocks or squares are so large that this economical depth is exceeded, the rear ends of the lots may well be thrown into one open space and used for parking. Incidentally such a use, meeting a real need, would greatly lighten the task of those called upon to enforce those sections of a building code requiring light and ventilation, and it would maintain the rental value of rear offices which would no longer be shut in by the solid walls of a neighboring structure.

Field for Private Enterprise

But as this phase of municipal service is likely to be slow in developing—though Chicago, for example, is already using part of Grant Park along Michigan Boulevard for parking, Cleveland and Detroit are more or less systematically utilizing open spaces, Brockton, Mass., has created an open space in the business district for this purpose, etc.—and never will meet fully the demand in the present centers of existing cities, there is a large field for private enter-

prise which would cater to those owners who have the means to pay for service, who wish their cars protected from storm and sun when not in use, who need mechanical assistance or who just feel more comfortable when their cars are safe from thieves.

To meet this demand a number of methods are now being tried out, ranging all the way from storage buildings several stories in height, equipped with ramps or automobile elevators, to the use of basements or cellars reached by ramps. Private initiative also has seized upon vacant lots and in some cases the back yards of business blocks, and is using these temporarily for automobile parks. What private initiative has here begun, indicates what municipal service can more adequately and systematically do. One rule to use as a guide here is that all such storage or parking spaces should have their entrances and exits—and they should have separate entrance and exit—on side streets or minor streets, where the constant crossing of sidewalks by automobiles will least interfere with pedestrians.

But so far as we now know, the use of all these methods to the utmost practicable extent will not meet the demand. Washington, which has a larger proportion of its downtown area given up to streets than any other city, which has many downtown streets so wide that cars can be parked at an angle on both curbs, seems to find the parking problem as difficult as other cities. The reason apparently is that the greater parking area results in a greater use of automobiles. It is the antithesis of New York City, where, in lower Manhattan, the very limited parking space almost prevents the use of private cars. That is, the greater parking space puts off the saturation point and thereby benefits the community.

Parking Motor Trucks

So far I have had in mind the passenger automobile, not the truck. The latter presents problems peculiar to itself. Except for the small retail delivery truck, its size alone makes difficulty. If parked parallel to the curb, it takes up a large amount of space and is placed inconveniently for loading and unloading. If parked at an angle it projects so far into the roadway and often so far over the sidewalk as to be a very real impediment to traffic.

Interior Versus Sidewalk Loading

In these days, when we are studying economies in the transportation of goods, we hear a great deal about store door delivery. This conjures up a picture of trucks running regular routes from railroad freight yards to the front doors of stores in the business section, backing up to those doors and unloading on the sidewalk. While this picture portrays quite accurately what does occur in some of our cities—witness the numbered streets on the west side of Manhattan Island—it certainly does not portray a workable system for the future. Loading and unloading of merchandise in quantity for business establishments must be done on spaces devoted primarily to that purpose and preferably on the private property of the business establishment.

It may be that New York, with its small blocks, and some of our other cities where construction has already filled the space behind building lines with structures which can be remodeled only at great expense, will have to compromise by setting aside certain minor streets for this purpose. But the way of the future would seem to be a requirement that the firm which constantly loads and unloads trucks shall do this work in a yard or a first story designed for the purpose and on its own property. Zoning will simplify this problem somewhat by tending to segregate establishments which require such service and so prevent their blocking thoroughfares used by the general public. But zoning is not by any means a complete answer, for department stores and many wholesale establishments will and should remain in and near the business centers, fronting on streets which carry great volumes of traffic.

Automobile May Reduce Crowding of People

In towns and smaller cities with their problems of size still in the future, in the still spacious suburbs of big cities, where city planning has today a fairly free field, there is opportunity to provide for future needs. The fundamental evil in our urban centers is the crowding of people too close together. The essential point to bear in mind in our new developments is the value of adequate open spaces. To create great parks and well equipped playgrounds as means of relief for those living huddled together in barrack tenements or packed into suffocat-

ing subways is but to give a mild antidote after administering a dose of poison. Human beings need space if they are to live and develop properly. Even in the congested downtown areas of our old cities the automobile may have some effect in thinning the population simply by occupying buildings or parts of buildings that otherwise would shelter swarming masses of people. In the suburbs and in the smaller cities they may prevent congestion by reason of the space they occupy.

The Little Business Center in the Big Town

We have long been familiar with the fact, though we have not always used that fact as a basis for reasoning, that a city normally grows by establishing a new little business center. We have interfered with this normal growth by some of our modern devices—for example, the retail business center of Jersey City was almost wiped out by the Hudson tubes—but in spite of us it continues to be normal. As with most normal things, there are very sound, wholesome reasons for this. One of them is that people wish to have their business places within walking distance of their homes. Another is that in the transactions of daily life most of us like to have human relationships. The housewife likes to know her butcher and to be known by him. As we grow snobbish we may change our objective to the head waiter of the Waldorf-Astoria or the proprietor of a lobster palace. But it is the same old craving.

Much Expected of City Planning and Zoning

Because city planning and its more popular twin, zoning, fit in with this craving for neighborliness, for knowing and being known, they are becoming an accepted part of city building. With them as our instruments we shall be able, among other achievements, to provide adequately for the storage and parking of automobiles in the as yet undeveloped urban areas.

Some months ago I spoke before the Business Men's Association of a thriving little business district in Washington. It has a branch bank, a large moving picture theater, grocery stores, butcher shops, dry goods store—all the necessary magnets for a family's income. I talked automobile parking space. The business men admitted that a large part of their trade, even though it seemed a neighborhood trade, came by automobile. They admitted that it would not be much exertion for their customers to drive two miles farther to downtown stores with larger assortments of goods. They accepted, though reluctantly, the theory that one reason their customers did not drive down town was the difficulty of finding parking space there. They admitted that parking space on their own streets was becoming scarce. But they halted at the novel suggestion that now is the time for them to get and hold as an automobile park, some vacant land in the neighborhood. That meant money. It meant a vision of the future. The effect of the Shriners' ban may convince them. But if not they, then the business men of some other center a mile or two farther out will make practical application of the lesson of experience. To provide space for automobile parking is good business.

Parking in Residence Districts

In my suggestions I have emphasized the importance of the automobile to business, and have done this for two reasons: First, because many of us are still inclined to regard the automobile as a pleasure vehicle except when it is in the obviously business form of a delivery truck; second, because our cities exist because of business. If it were not for business there would be no cities, no means of paying taxes, no pay envelopes from which to extract the wherewithal for rent and food and clothes—and automobiles. So it is necessary to consider the automobile as a facilitator of business. But business is not an end in itself, it is simply a means to an end. Its purpose is to enable us to live more abundantly. Consequently we can not stop with the automobile in the business district, but must follow it home to the residence district. Here, in areas where apartment houses have multiplied, we find almost as acute a situation as we do down town. Parked automobiles line the curbs in solid rows, and still there is not space enough.

In residence districts there are at least two considerations which make the situation different from that in business districts. Nearly all the differences over which men become excited are not differences of kind, but simply differences of degree, differences of emphasis. Here is such a difference. A business street, the frontage of a business block, is much more a community property

than is a residence street, the frontage of a residence block. A citizen or a tourist may have a perfect right, based upon the general good, to park his car in front of your store and leave it there, while he may have no such right to park and leave it in front of your house.

If only an occasional stranger parks his car before your house and does it only on occasional days, the annoyance is so slight that you will probably pay no attention to it. But if the curb in front of your house is constantly occupied by the cars of strangers so that you can not drive up to your own front door and so that your visitors have to leave their cars at a distance; if the starting of motors and the smell of gas constantly wreck your quiet and peace of mind, you have legitimate cause for complaint.

Here, then, is the basis for another generalization to use as a guide, that in residence districts cars may be parked along the curb only in front of the residences of their owners or the residences of those upon whom their owners are calling. This is a rule to be often honored in the breach and it is necessitated chiefly by the abuse which follows the intrusion of large apartment houses into districts of one-family homes. These apartment houses now derive a large part of their attractiveness from the fact of their being surrounded by homes, and in return they are usually a decided detriment to the homes upon which they sponge. They should not be permitted to add to the damage they cause by lining the streets far beyond their own frontages with the cars of their occupants. The cars of one large apartment house can quickly depreciate the value of residence property for a considerable distance.

The second consideration which differentiates business district parking from residence district parking, is that in the former parking is nearly always only a day-time affair, or, near theaters, an evening affair, while in residence districts, especially in these times of high building costs, it tends to become an all-night affair. While admitting the practical difficulties faced by the car owner due to building costs, it should be the rule that all-night parking of cars on public streets be forbidden. The owner may not be able to build a garage now, but he should at least drive his car onto his own lot. If he lives in a row house erected upon a lot so small that it contains no space for a car, or if he lives in an apartment house which provides no storage facilities for its tenants, then he is under the necessity of renting garage space somewhere else.

The reasons for this distinction as between business districts and residence districts are fairly obvious. A parked car at night, especially on a dimly lighted residence street, is a hazard to moving vehicles even if its parking lights are kept lighted. A car at night, especially in residence streets, presents more difficult police problems; it is a shelter for clandestine doings; it presents greater opportunity for thieves. Moreover, the requirement that there be provided space on private property for the night storage or parking of automobiles is in line with the sound policy that our people should have adequate space in which to live and grow and move.

Some Remedies of Doubtful Value

You will have noted that in this discussion there is no suggestion for automobile subways or for double-decked streets or for sidewalks raised a story above the roadway. All of these have been suggested in more than oue city and in New York such suggestions have assumed very definite form. My belief is that automobile subways would be not only ruinously expensive but that they would be community liabilities in other ways. Double-decked streets might cost less to construct, but they would be quite as injurious to those who must use the close lower level. An argument may be made for such construction if it is of small extent and undertaken in connection with other improvements, as on South Water Street in Chicago, but this is exceptional. Raised sidewalks would provide a great amount of parking space beneath but, even assuming that they can be hung on brackets or supported in some other way not necessitating posts or pillars which create a hazard for traffic, they, with the required bridges across intersecting streets, would shadow and darken the roadways and parking spaces below.

Our modern means of transit, including the automobile, make it possible for us to spread out our population instead of herding it in compact masses. In the past we have talked distribution, but have practiced concentration. Now let us practice what we preach. There is

plenty of land available in America, our chief handicap in utilizing it is our blind following of habits acquired when we had to do all our traveling on our own two feet, or at best on the four feet of a horse. Open air and sunshine are the greatest agents for human health and happiness. They are to be had in inexhaustible quantities, but we have perversely exercised our ingenuity to deprive ourselves of them and then furnish artificial substitutes at great cost.

By proper city building, by intelligent grouping of industries, commerce and dwellings, we can reduce real distances, i. e., the distances each individual must traverse in his daily routine, to a fraction of what they now are in our largest cities. By limiting the proportion of an area that may be built upon and by limiting the height of buildings we shall prevent any duplications of the lower end of Manhattan or the loop district of Chicago or the center of Los Angeles. Then the more economical, more wholesome, more cheerful open street will serve our needs adequately and cause us to regard with pity the inhabitants of those cities whose past mistakes force them to live the lives of ground hogs burrowing their way through subways and under double-decked streets from apartments whose windows never catch the sun to gloomy offices whose chief illumination is furnished by the kilowat hour.

A generous provision of open streets will prove far less expensive to construct and maintain than would such underground passageways. As a basis for determining what is adequate I would suggest:

On main streets in retail districts the roadway should be wide enough for a line of cars on each side, parked at an angle of 45 degrees, for a line of traffic in each direction and for two trolley car lines. In this case the parked automobiles would be along the curbs. If the street is enough wider to permit two lines of traffic on each side, so that the stopping of an automobile for a moment would not halt traffic, the parked automobiles may be put near the center of the street flanking the trolley car tracks, so leaving the curbs available for discharge of passengers. This also has the advantage of preventing automobiles from using the traction right-of-way and so impeding trolley service. Otherwise it is necessary to keep the traction right-of-way available for automobile traffic, which will occasionally have to circle about a stalled car.

On secondary business streets the width should permit of two lines of cars parked parallel with the curb, though parallel parking is not so good as parking at an angle.

In apartment house districts streets should be wide enough for parking at an angle.

In one-family house districts there should be no need of providing for continuous lines of parked cars. Unnecesrary width of roadway means unnecessary cost for the home. It is cheaper to park one's car in the yard.

The foregoing paper by Mr. Ihlder was read at the recent annual meeting of the New York State Conference of Mayors and Other City Officials.

REVISION OF BAD LAW STIMULATES MUNICIPAL IMPROVEMENT WORK IN MISSOURI

By F. H. Frauens, of W. B. Rollins & Co., 521 Railway Exchange Bldg., Kansas City, Mo.

The recent activity of a number of Missouri cities in the construction of sanitary sewer systems brings to mind the stimulating effect that the correcting of inequitable laws may have on public improvement work.

Up until a few years ago, Missouri cities of the third and fourth class could vote bonds for public improvements in an amount of not to exceed 5 per cent of the assessed valuation, which meant that after bonds had been voted for water or light plants, there was usually no margin left for sewer systems, especially since it was the general practice to make assessments of property much below the actual value.

This left only one way open for the construction of sewer systems; that is, by the issuance of tax bills. By this method the work was constructed by order of the City Board, and special tax bills issued against the property benefited. This method was unsatisfactory for two principal reasons; first, because the tax bills could run for not to exceed three years, bearing interest at 8 per cent, and second, because the assessment was made on the square foot basis. Another reason was that since the law stated that the tax bills must be turned over to the contractor in payment for his work, it was

necessary that they be discounted from 15 to 25 per cent in most cases. The result was that movements for the construction of sewers in a large number of good, prosperous towns met these objections and the improvement was not made.

About two years ago, however, an amendment was passed which allowed the issuance of bonds for water, light and ice plants in an amount of 10 per cent of the assessed valuation additional, which thus left the original 5 per cent available for sanitary sewer systems.

During the year of 1923 quite a number of bond issues for sewerage purposes have carried, some of them being in towns where this improvement had been continually agitated without success before. Probably the first city to put the proposition through was Harrisonville, population 2,100, where a $60,000 bond issue for a complete sanitary sewer system carried in December, 1922, by a 10 to 1 vote. The proposition had been considered and turned down a number of times in the past six or seven years when it was proposed to issue tax bills in payment, and the large majority by which the bond issue carried is a good indication of the advantages and popularity of the bond method. Since this issue was put over, the following towns, all in Missouri, have voted bonds for complete sanitary sewer systems and for the water works improvements necessary to furnish water for the operation of same:

Salisbury, population 1,800, bond issue $50,000; Chamois, population, 700, bond issue $30,000; Edina, population 1,500, bond issue $120,000; Canton, population 2,400, bond issue $80,000, and Unionville, population 2,200, bond issue $80,000. In addition to these, elections were held in September at Greenfield, population 1,500, amount of proposed issue $60,000, and Kahoka, population 2,500, amount $75,000. These are only projects on which the firm of engineers of which the writer is a member has been engaged, and in addition there have been several similar jobs handled by other firms.

Since there has been no marked period of prosperity or awakening of public spirit this year in Missouri, nor is there any other possible reason for this activity in the construction of sanitary sewerage systems except the change in the Missouri law mentioned above, it is reasonable to assume that it was the fact that it was possible to install sewer systems on an equitable basis that was responsible for the change, and hence the general conclusion may be drawn that municipal improvements of all kinds are strongly influenced by the kind of laws under which they may be secured.

SOME PRESENT ASPECTS OF PUBLIC UTILITY APPRAISALS

By Edward W. Bemis, Consulting Engineer, 139 N. Clark St., Chicago, Ill.

Except for an occasional appraisal of a water works plant for municipal purchase, there was no appraisal worth mentioning of any public utility or steam railroad in America, or probably in Canada, prior to 1900 and very little prior to the New York City Consolidated Gas case before the Federal Court in 1906. There were a few gas appraisals before the courts soon afterwards, as in Cedar Rapids and Saginaw. Appraisals on any large scale, or pursued in any scientific manner, virtually started with the beginning of state commission regulation in New York, Wisconsin and New Jersey in 1907, followed by other states in rapid succession and by the Interstate Commerce Commission in 1913. Massachusetts, to be sure, had been regulating her gas and electric light utilities through a State Commission since 1884, but had based that regulation on the book records and reports to the Commission as to actual investment, without such check as to depreciation as would have resulted from a careful appraisal.

Why Appraisals Are Made

Appraisals of properties of much size, outside of water works, have been mostly for purposes of rate regulation. Some have been made for purposes of security issued and some (mostly small water and electric plants) for purposes of public purchase. The number of appraisals for public regulation seems likely to decrease because appraisals once made are often brought up to date by taking account of property added and retired and perhaps by some arbitrary percentage added to the old appraisal to represent estimated changes in unit prices. Appraisals for public purchase are likely to increase with the growth of the public ownership movement.

Public Side of the Question Neglected

It is exceedingly unfortunate that, whereas the utilities recognize the importance of appraisals for every purpose, our cities and the public at large do not realize the vital importance of these ap-

praisals, whether for the issuance of securities, the regulation of rates or for public purchase. The consequence is that the public side of valuation work is not as carefully and fully presented to courts and commissions as is the company's side.

One important reason why, for example, many utility decisions lean more to reproduction cost at present prices than to original cost or actual investment, is because the companies—following their immediate self-interest—have presented present reproduction cost with no end of thorough preparation and careful detail, while the public have gone to sleep and have left their attorneys that often hold public office only for short periods of time, to fight out these matters without any adequate engineering, accounting or other help.

What Happened at Seattle

Seattle's grave difficulties with her street railways arose from the purchase of the property without any appraisal and naturally, under those circumstances, at a very high valuation. In the case of public purchase, it ought by this time to be recognized that an appraisal, with full regard to existing depreciation from obsolescence and inadequacy, and from the growth of public demands for the burial of wires, improved foundations for rails, etc., is fundamental.

The Case of Public Purchase

What isn't so clearly understood—and indeed among friends of public ownership is hardly understood at all—is that appraisals for rate regulation or for the issuance of securities are also vital, not only in their bearing upon the purposes of such appraisals, but upon the purchase price in case municipal ownership is sought. A valuation once fixed for any purpose, whether for taxation, regulation or issuance of securities, is likely to have great weight with a commission or court in a later valuation for public purchase. Furthermore, and this must not be ignored, the profits obtained under rates fixed by a commission or court on the basis of an appraisal for rate regulation will largely affect values in case of public purchase. In the latter instance much weight is given not only to appraisals at present prices, but to the capitalization of present and prospective earnings under the system of regulation in vogue.

For example, if a commission allows a 7 per cent return on $2,000,000, on the theory that that is the cost of reproduction less depreciation, or $140,000 a year, instead of allowing 7 per cent on $1,000,000 or $70,000 a year, in cases where the $1,000,000 represents the original cost less depreciation of the property now in use, the result in case of public purchase is marked. A utility earning $140,000 a year might easily be capitalized in public purchase on a 6 per cent basis, i. e., for over $2,300,000, whereas if it were earning only $70,000 a year on the same physical property, actually costing the same as in the previous case and equally depreciated, the price in case of sale might easily be only half as much as in the other case.

Disagreements on Elements of Value

It is, of course, not assumed or contended that any appraisal for any purpose should be lower than what our highest courts consider fair and equitable, but there is such a divergence of opinion even in our Supreme Court in different cases as to the relative weight to be given to various elements of value, that a strong presentation by any public body of such an element of value as original cost less depreciation, or of the actual investment in the property by stockholders and bondholders, accompanied by the record of its past earnings and their disposition, is bound to have a great influence in determining the rate base and consequently in determining the earnings thereon, and therefore the purchase base whenever that becomes a practical issue.

The Decisions of This Year

The three valuation decisions of the U. S. Supreme Court in the Missouri Bell, the Bluefield and the Georgia Power cases this year indicate that however much some of the justices lean toward present reproduction cost, the court is not likely to upset any commission decision which allows for the present value of the land and either the original cost less depreciation of the property now in use or the reproduction cost on pre-war prices of the property in use at the beginning of the war plus subsequent additions at cost, provided a return of 6 or 7 per cent on this valuation is granted.

When utilities present elaborate appraisals and, based thereon, seek official approval for the issuance of new securities on top of those already out, which may be to a considerable extent water, cities often so little appreciate the situation as to make no critical examination of the companies' appraisal. The cities sometimes are not even represented at

such a hearing, yet the valuation then fixed and the securities then allowed may greatly affect any subsequent decision of court or commission with respect to rates or purchase.

Only a Beginning Made

Only a beginning, however, has been made when the importance of an appraisal is recognized. Appraisals will be a snare and a delusion unless our elective bodies of our governors and presidents, as the case may be, put upon our commissions and courts, and unless our cities select as their appraisers men who have the public point of view instead of those who, by training and habits of thought, are in sympathy with the corporation point of view, or who hope to be attorneys or engineers and appraisers for our public utilities after securing some prestige in our courts and regulative bodies. There is such a fundamental difference in the attitude of appraisers for companies and for cities or other public bodies in the treatment of depreciation, going value, the weight to be given original cost, investment, etc., that it is about as hard for an engineer or an attorney to serve with equal ability and success a company today and a city tomorrow in a rate or purchase case, as it is for the camel to go through the traditional eye of the needle. Engineers, accountants, commissioners and attorneys can agree on the physical and financial facts in a given case, but the real weight to be given these facts and the conclusions to be drawn from them in any rate or purchase case depends so largely upon one's point of view with respect to ethics, economics and public policy, that I have yet to meet a man who can equally well serve both the public and private companies in appraisal work.

What an Appraiser Must Know

In the next place, qualifications now required in appraisal work cover not merely purely engineering and accounting data. It will pay to dwell upon this a moment. The appraiser must be familiar with our highest court decisions. The average corporation counsel or attorney-general—busy with many lines of legal work—must largely depend on an appraiser's thorough knowledge of adjudicated cases affecting the question in hand. One must know how to use the books and other records of a company and direct the accounting investigation; he must understand the various theories of depreciation and how to apply depreciation consistently with respect to both annual and accrued depreciation, whether on the straight line or sinking fund theory. The appraiser must know how to determine the cost of reproduction of a property at the average prices of 1911-15 inclusive, and must be thoroughly acquainted with necessary overhead charges in both original cost and reproduction and be able to criticise the accuracy of any appraisal presented by a company. In the Georgia power decision, handed down June 11, 1923, the United States Supreme Court held that the Commission had paid sufficient attention to the present cost of reproduction when it had valued the depreciable property in existence Jan. 1, 1914, at "substantially its actual cost or its reproduction cost as of that date," together with the actual cost of subsequent additions and land at its present value. It therefore becomes desirable to set up the original cost, actual or estimated, and as an alternative proposition, the reproduction cost on pre-war prices, which are usually taken as the average of 1911-15 inclusive, plus the actual cost of subsequent additions.

Then as a basis for a going value exhibit there should come a careful study of the past profits and their relation to the yearly investment from the beginning of the company. The rates at which public utility securities are floated from month to month and year to year must be presented clearly and in detail. Even though the conclusions reached are presented as merely advisory or suggestive to a court or commission, a proper appraisal requires an able combination of engineering, economics, law and the consideration of questions of public policy on the part of the appraiser.

Railway Valuation

The greatest problem of internal policy confronting the Congress of the United States the coming winter has grown out of the refusal up to date of the Interstate Commerce Commission to obey the Railroad Valuation Act of 1913 and present to the country the original cost of the present property of the railroads and the value of the aids, gifts and grants to them in lands and cash by governmental bodies. The Commission admits that the Valuation Act can be obeyed, although it claims at a cost of perhaps $25,000,000, and merely asserts that it did not believe Congress intended any original cost or the amount of aids, gifts and grants to be set up unless found in the existing

books and records of railroad and telegraph companies. In other words, they strangely contend that no estimates must be used of original cost to supplement such records as are extant.

In comparison with the importance of the information called for by the Act, the cost of getting it, even if it should be $50,000.000, is a mere bagatelle where billions are at stake. Far more in values is involved than the price of the four million negro slaves in America in 1860 which, at $500 each for man, woman and child, would have amounted to only $2,000,000,000. Nor is this all! The Valuation Act of 1913 required the determination of reproduction cost and of original cost. If our United States Supreme Court has before it (as it will have unless something is done) only the opinion of the Interstate Commerce Commission as to reproduction cost, although on pre-war prices, there is every reason to fear that the court—having no original cost to tie to—will say that reproduction cost must logically be brought up to date by applying some percentage indicative of the increase of prices, and we shall end with a valuation so much higher than the tentative valuation used under the Esch-Cummins Act of $18,900,000,000, as very likely to exceed by $10,000.000,000 the actual cost less depreciation of the property now in use.

Nor is even this all! The ignoring of original cost by our United States Supreme Court in the absence of any evidence of original cost on our railroads, will serve as a precedent in all our city utility cases and in all our state-wide telephone cases. The margin between actual cost and reproduction cost on present prices in the case of the city utilities is as much as in the case of the railroads, or another $10,000,000,000. Our utilities and railroads are no longer afraid of the exposure of their watered stock and sometimes even watered bonds, since they have found it possible to lull the public to sleep while they pad their rate or purchase base with present reproduction cost and high going values, with ridiculously small allowances for accrued depreciation.

If our cities and other public bodies would only go to the expense of securing and properly presenting the original cost less depreciation, and other matters outlined above, and employ competent engineers committed to the public point of view, our commissions and courts would render much lower decisions as to rate and purchase bases, in most of our public utility cases, than they do now. Our cities and citizens cannot afford to leave investigations and appraisals to commissions, but must present to these bodies as carefully prepared appraisals as if before a court or, as very often happens, these commissions, which are quasi courts and poorly equipped financially for complete appraisals, will be unduly but naturally influenced by the weight of evidence submitted by companies—which frequently spend three dollars to a city's one in a rate or purchase case.

Is it not time to wake up on this question of appraisals?

The foregoing paper by Mr. Bemis was presented at the 1923 meeting of the Municipal League of Indiana.

SOME SUGGESTIONS FOR MUNICIPAL TRAFFIC RELIEF

By H. W. Slauson, M. E., Engineering Service Manager, Kelly-Springfield Tire Co., 250 W. 57th St., New York, N. Y.

I believe there is one practical suggestion which should be adopted by every city in which street congestion is serious. This relates to the traffic confusion which is so greatly aggravated by the trolley, which not only controls the speed of travel on its own track but which may also bring several parallel lines of vehicles to a complete halt every time it stops to take on or discharge passengers—and during the rush hours when automobile congestion is greatest, this trolley interference is at its maximum effectiveness.

Most of us no longer agree with the radicals that the trolley should be legislated out of existence. Heretofore it has represented a legitimate investment. It pays, when it is able, a high franchise and tax rate and is frequently compelled to keep the pavement between its rails, and for a certain distance on either side, in better condition than the city maintains its own streets. Furthermore, after a severe snow storm it is frequently only the trolley right-of-way which has been plowed, swept and made passable for other vehicles.

But, where the trolley should have the privilege of controlling only a single line of traffic, in reality, as has already been pointed out, it controls every line of traffic between its rails and the curb and will continue to do so as long as every street

corner becomes a station for the arrival and departure of passengers.

To lay the rails at the side of the street close to the curb would greatly lessen the congestion of moving traffic, but is impractical because no motor cars could be parked at the curb. The elimination of the rails by the substitution of rubber-tired trolley buses with flexible connections with the overhead power wires has been tried successfully. But, in many instances, these rails must be used for long distance and suburban traffic, and at any rate, the tracks, conduits and third rails represent an investment which many trolley companies will not willingly throw away. Therefore, inasmuch as it is the frequent stops of the trolley which add so greatly to traffic congestion, let us reduce the number of these stops as much as possible.

Effect of Trolley on Other Traffic

Trolley transportation should prove a supplement to, rather than a detriment of, street traffic. Why could not existing trolley companies use their rail equipment for long distance hauling with no intermediate stops to take on or discharge passengers? The short haul traffic could be handled by means of supplementary motor buses owned by the trolley company and operated either by gasoline engines, storage batteries or flexible connections with the overhead trolley wires. Such buses could stop at the street corners as easily as a private automobile and could carry all of the local traffic with arrangements for transfers at points one or two miles apart at which the rail-bound trolley cars could stop. The rail-bound trolley, with its infrequent stops, could then travel as fast as its own line of traffic would permit. Under this arrangement passengers could be carried more quickly either by the short haul bus or the express trolley, than is possible under present conditions of traffic. It may be argued that the increased number of buses would so add to highway congestion as to neutralize their benefit, but they could replace almost an equal number of trolley cars now used for the short haul traffic, and because of their ability to pull directly up to the curb to receive and discharge short haul passengers, and to weave in and out of traffic without restriction to rail, I am very positive that the carrying capacity of our streets could be materially increased.

Stationary Traffic

But traffic cannot keep moving continuously; cars are on the street because they have some definite destination in view and this brings us to the most serious of our municipal problems—stationary traffic. If we adhered to the letter of the non-parking restrictions, the ten-minute parking limit signs and the admonitions of some of our city court justices, we could not even stop our car for lunch.

It is not the province of this discussion to describe the various means employed in many of our cities by which parking space may be secured. Diagonal parking, parking in the center of the street, parking with wheels directly against the curb, and side parking are methods entirely dependent upon local conditions.

Temporary Make-Shifts

Some cities are setting aside public squares and parks for the accommodation of stationary traffic. In other cities, large department stores maintain a free garage for their patrons with a service which includes bringing the car to the door when the customer is again ready for it.

But these attempts to improve conditions can be but temporary make-shifts of a situation which is inherently and basically wrong. Ten years ago we were all talking of the saturation point and of the continued ability of the country to absorb new automobiles, and we little dreamed that the real saturation point was the ability of our streets to accommodate the cars already in use.

I am not a close student of traffic conditions and I have no statistics other than those based on daily observation, but I ask you if it will not be absolutely impossible to accommodate on two dimension roadways, occupants of cities who are continually living in three dimensions, for our cities are no longer planes, they are cubes; the third dimension is used by every architect, building contractor and real estate man who wants to add to the value of his property through its ability to accommodate more human beings.

Effect of High Buildings

Just think what it means, for example, when a 20-story office building or apartment house is erected on a certain site. Such a building may well occupy an entire block and may easily replace 30 or 40 houses, each of which accommodates one or two families. If each family owned a car and if each entertained a guest simultaneously who also came in a car, there would still be room at the curb for

the maximum number of 75 or 100 cars involved. Now when these houses are demolished and we add the third dimension to this block in the form of the 20-story apartment house, we may find 200 or 300 families occupying the same ground space which formerly accommodated 30 or 40 families, but under modern conditions of construction and planning, the car parking space has not been increased and there is still no more room at the curb for the cars of tenants and friends than was the case when three-story single dwellings occupied this block.

What is one of the first items that the architect considers when designing his building? He calculates the total area of floor space, estimates the number of persons who will be accommodated on each floor and then allots space for an adequate number of elevator shafts to take care of the vertical traffic. No well-designed and well-managed building will permit of undue elevator congestion even during rush hours, and in consequence far better provisions are made for this third dimension traffic than are available for the tenant of that building whenever he desires to travel in a horizontal direction. Such a tenant, after having been whisked rapidly down to the ground floor, may find that his wife, his chauffeur, or whoever else may be driving his car down for him, have been unable to find any parking space near the building and has been forced to drive around the block continuously. This "merry-go-round" parking is becoming the only solution of the problem in certain sections of our cities.

Here again, we are confronted with the absolute necessity of adding the third dimension to our parking spaces as well as to our highways. We have added the third dimension to our rail-controlled city traffic in the form of elevated structures and subways, but we have as yet found no satisfactory solution other than vague plans, to the problem of securing the third dimension for motor driven traffic, and this traffic relief is vitally needed and must therefore be susceptible of immediate application to existing conditions. It is all very well to plan for the ideal city of 100 years from now, but the problem is not one for our children or future generations to solve, it is one for us here and now.

Problem of the Stationary Car

I firmly believe that the problem of the stationary car is far more serious than that of the moving vehicle. The seriousness of the situation lies not so much in present conditions as in the fact that we are doing nothing to prevent a very serious aggravation of these conditions within the next two or three years. Possibly a remedy must be brought about by legislation. It is true that there are already too many laws, but legislation which will insure adequate parking space for the cars of the future is far better than legislation which will prevent the efficient and effective use of the cars already in operation. The automobile is too effective a tool to have its efficiency curtailed in the slightest by half-baked ideas such as have already been proposed, and which have as their object a reduction in the number of cars which shall use the streets and a restriction of the areas in which they may be kept. You cannot legislate crowds and lawful pedestrians off the sidewalks and it would be equally ludicrous or impossible to prevent highway congestion by saying that cars or trucks belonging to certain individuals shall not be used except, possibly, under given conditions, such as certain hours of the day or certain days of the week.

We must get at the fundamentals and so arrange and design our cities that, as the city grows in population, its ability to accommodate stationary and moving traffic will grow in the necessary proportion. Therefore, the blame for traffic congestion in reality lies with those who are responsible for population congestion and to them we should look for the remedy.

Examine the surrounding street of any large apartment house or office building. We find that such a building, while of course not gasping for air, is literally gasping for parking space. It has reached out its tentacles in all directions and has pounced on every street radiating from it as a center in order to furnish parking space for the cars of its tenants and customers. Nearby private houses which may boast of but one automobile, have their entrances blocked by the cars of those doing business in that building. A nearby public garage is hardly the answer to the problem, for this in itself would occupy valuable ground area and would not be used by those who came to work early enough to find sufficient parking space near the entrance to their building.

Providing Parking Space in Large Buildings

My proposal is merely that, as every modern building is required to devote a

certain proportion of its area to elevator and fire escape requirements, so in the large buildings of the future we should require that they furnish adequate parking space within themselves. This will employ the third dimension—which is the cause of traffic congestion—as a means of relieving that very congestion. This is not so difficult as it might sound, for one sub-cellar or lower floor of the building which may be connected with the street by ramps, could be made to furnish automobile storage space equal to at least 5 per cent of the available rental area of a 20-story building. This would, of course, reduce the rental return of the building by 5 per cent, but if department stores have found it advantageous to rent or construct free garages for the benefit of their patrons, the owner of an office building or apartment house would find it equally "good business."

But we are not considering good business from the aspect of the real estate man. Zoning laws of our cities which have regulated the height of our buildings in order to preserve the architectural beauty and give adequate light to the streets below, have also served to reduce the total gross receipts which may be obtained from a building occupying a certain plot of ground. On the other hand, the benefit to the tenants of the entire neighborhood has been such that net revenues have not been decreased and landlord and tenant alike have been benefited.

Third Dimension Parking

We carry out the same principal of third dimension parking in our suburban homes where many garages are built of fireproof construction directly in the house, as a part of the cellar. Apply this same idea to an office building, making the storage space thus formed available upon payment of a small fee to every tenant who has occasion to leave his car in this vicinity for more than, say, 30 minutes, and you will find an automatic solution of the parking congestion problem which *will keep pace with the growth of the city.* The curb space will then be left free for the cars of clients, customers and others having occasion to leave their vehicles for only a short time.

The foregoing is from a recent address by Mr. Slauson at the convention of the Motor and Accessory Manufacturers' Association at Boston on Sept. 21, 1923.

PROGRESS IN SOLVING THE SEWAGE SLUDGE PROBLEM

(Editor's Note: The full text of the report of the Committee on Sludge, of the American Public Health Association, as presented at Boston, Mass., on Oct. 10, 1923, is here given. Members of the committee are: Langdon Pearse, chairman; T. Chalkley Hatton, C. H. Hurd, Earle B. Phelps and W. L. Stevenson. As the work divides particularly by the organizations handling the investigations, the report is so outlined.)

Milwaukee Sewerage Commission

Mr. T. Chalkley Hatton gives the following notes on the Milwaukee work:

The Milwaukee Sewerage Commission appointed a Fellow to the Agricultural College of the University of Wisconsin who has devoted his entire time to the use of sludge in agriculture. Intensive studies have been made of the values of activated sludge in comparison with commercial fertilizers of different mixtures. Plantings were made of corn, soy beans, Sudan grass, tobacco and other crops at the experimental farms of the University of Wisconsin, at Marshfield, Hancock, Codington, Madison and Wauwatosa. To determine the value for grass in golf greens, tests are being made at the Blue Mound, Ozaukee, Lynx and Tripoli Golf Clubs, and the Milwaukee Country Club and the Pine Bluff Country Club. A large number of pot cultures have also been made at the greenhouses of the University of Wisconsin.

The National Fertilizer Association has also been advised of the possible value of activated sludge. Samples have been sent various fertilizer distributors for investigation. The co-operation of the Executive Committee of the Association has been assured in handling and marketing the prepared sludge should it prove as satisfactory as appearances indicate.

Sanitary District of Chicago

The Sanitary District of Chicago has interested a number of agricultural experiment stations in growing tests. Work is under way on cotton in Mississippi, and on garden plants at the University of Illinois. In the Chicago territory sludge has been distributed to peony and rose growers, truck farmers, cabbage growers and to various individuals. The Lincoln Park, West Side and South Park organizations are trying sludge on lawns and grass plots.

The district has operated a test plot

during the growing season, planting corn, beets and beans, with various combinations of fertilizer. Some 45 plots, each 1,100 sq. ft. in area were planted. The land, while formerly used for truck gardening had lain idle for over four years. The results in general have been encouraging. A record of weights is being kept, as the vegetables are picked, which will furnish a criterion of the real relative production.

In addition, the district has used sludge in seeding grass, in comparison with sheep manure.

The best price obtained during the year on the sale of carload lots was $9 per ton f. o. b. cars for sludge, dried and bagged.

Baltimore

Mr. Milton J. Ruark, Division Engineer of Sewers, gives the following notes of interest with reference to the sludge handling problem of Baltimore. During the year 1922, the total production of sludge was about 5,400 tons on a dry basis. This is the greatest rate of production in any year since 1918, when the output was somewhat greater. During 1922, about 5,500 tons on a dry basis were handled, a portion of this being heat dried sludge from the drying plant and the remainder air dried sludge taken by local farmers. For more than a year no charge has been made for air dried sludge. This season farmers have taken the sludge as often as it is produced by the sand beds, so that the drying plant has not been operated for several months.

At the present time, no income is being realized from the sale of sludge. The city has provided means to load the farmers' trucks from a trestle by dump cars direct from the sand beds, or by a derrick from the storage pile. As a rule the farmer arranges to handle sludge only when the city is operating one of the loading devices. Occasionally a farmer loads his own truck. The sludge is all used within a radius of about 4 miles, whenever possible, the farmers hauling it directly to the field, where it is spread and plowed under. Sometimes it is placed in piles or composted with manure for spreading on the fields at a later date. The farming community served is almost entirely composed of truck farmers. The sludge is therefore used to a large extent for such plants as cabbage, spinach, potatoes, string beans and tomatoes. It is used to some extent on corn, and to a very limited extent on grass. The amount of horse and cow manure available has decreased markedly in the last few years with the result that its cost has reached a point where farmers are seeking other materials for fertilizer. While it is evident that the farmers in the vicinity of the Baltimore plant believe the sludge is worth the handling, the city officials have desired to satisfy themselves of the real value of the sludge in agriculture. In co-operation with the Agriculture Experiment Station of Baltimore, a series of experiments have been outlined to extend over some 4 or 5 years. Nine acres have been laid out in 6 sections of 1½ acres each, each section being divided into 6 plots of ¼ acre each. The whole of each section has been treated with one of the following fertilizers: Liquid digested sludge, air dried sand bed sludge, commercial fertilizer, commercial fertilizer and dry sludge and manure. As a control, one plot has been given no treatment. One-half of each section then was treated with lime in a manner to cover half of each plot. In one plot of each section will then be planted some crop, and likewise with each of the other plots, so that in any year some crop will be growing on ground treated with all of the six fertilizers, both with and without lime. Rotation of crops will probably be introduced, but the ground will receive the same fertilizer year after year. A special experiment with alum treated sludge will also be started on other ground.

At the date of September 15, the farm was already growing late potatoes, beans and fall cabbage. It is proposed to plant spinach and grass seed in the fall and next spring to add another crop, probably tomatoes, making a total of six different crops.

The preparation of air dried sludge for the year 1922 cost $.666 per ton.

Rochester

Mr. John F. Skinner reports that at the Irondequoit plant of the city of Rochester, N. Y., about 10,600 cu. yds. were prepared for market in 1922 by air drying. This sludge was sold at an average price of $0.75 per load of 2 cu. yds. to farmers, delivery being made by a tipple to the teams and auto trucks. When shoveled from storage only $0.50 was received by the city. The sludge is largely used in the top dressings of the orchards for a distance of 7 miles around the plant.

Houston

From Houston, Mr. J. C. McVea reports that during the calendar year 1922, 4 cars

of sludge were sold. The buyers preferred sludge which had not been pulverized. Five tons were delivered to local truck growers and others for use near Houston. The results obtained by various gardeners and by the Houston City Park Superintendent on the municipal golf course and in the parks have been very gratifying. Growing experiments were made on a small scale with turnips, tomatoes, lettuce and radishes, in which the value of the sludge as a fertilizer was demonstrated. In particular, the turnips were vastly improved, the ones fertilized with sludge being the only ones edible, being sound and sweet, the others being dry and fibrous. The results on the turnips are given by the following table:

PERCENTAGE INCREASE OVER UNFERTILIZED TURNIPS

No.	Wt. Tl.	Ozs. Rts.	Tps.	% Increase Tl.	Rts.	Tps.	How Fertilized
1	11	3	8	0	0	0	Not Fertilized
2	18	7	11	64	133	38	Blood
3	41	14	27	273	367	237	Nitrate Soda
4	63	28	35	473	832	338	Activated Sludge
5	59	31	28	436	932	250	Activated Sludge and Phosphoric Acid

Preparation of Sludge

In the preparation of the sludge, development of methods and apparatus is still progressing with very encouraging results.

At Milwaukee, the tests have been concluded on sludge handling, with the conclusion that provision should be made for the use of acid and heat with the Oliver filter.

At the Des Plaines River Sewage Treatment Plant of the Sanitary District of Chicago dewatering has proceeded using alum or acid, with and without heat. At first only a Worthington bag platen press and a Simplex plate press were available. In August tests were begun on a novel hydraulically operated bag press, designed by Berrigan, with direct squeeze, which has the advantage of taking care of any desired thickness from ¼ in. upwards. The press cake (in moisture content from 73 to 83 per cent moisture) is dried in a rotary direct-indirect dryer. A pulverizer is required to crush the balls which occur, though not in large numbers.

At the Calumet Sewage Treatment Works of the Sanitary District of Chicago, dewatering has proceeded using alum or acid on the Oliver filter installed. This filter is the largest size built, the drum being 11 ft. 6 ins. diameter with a face 14 ft. wide. Space has been left in the house for a Basco-ter-Meer centrifugal. A dryer similar to the one at the Des Plaines River Sewage Treatment Works operates on the sludge cake intermittently.

At the testing station, operated jointly by the Sanitary District and the Corn Products Refining Company at Argo, tests have been run on plate filters and a single wheel American rotary filter. Alum has proved more successful as a coagulant than acid.

At Houston, the cost of preparing the sludge has not yet developed to a point where definite costs can be given. Several methods have been tried. At present the use of sulphur dioxide gas is being tried to prepare the sludge for pressing. There has been no complaint of odor from sludge handling or the preparation of the sludge.

The nitrogen recovery in activated sludge at the various points of operation is as follows:

ACTIVATED SLUDGE

Recovery of Nitrogen and Phosphoric Acid
Nitrogen as N; Phosphoric Acid as P_2O_5
Per cent dry basis.

Location	N	P_2O_5
Sanitary District of Chicago—		
Argo	7 to 8	6 to 7
Tannery	3.0	
Packingtown	4.2	2.7
Des Plaines R.S.T.W.	4.5 to 5.5	2 to 4
Calumet S.T.W.	4.2 to 4.4	
Houston	4.6	1.9
Milwaukee	6.0	2.3

By the alkaline permanganate method the total available ammonia in the Milwaukee sludge is 4.61 per cent, 63 per cent of the total ammonia.

TABLE 1—PRODUCTION DATA AND ANALYSIS OF SLUDGE REPORTED FOR 1922

City and Plant	Baltimore—Hydrolytic	Rochester—Imhoff	Chicago—Activated	Houston—Activated
Production in 1922, net tons dry weight	5,421	6,440	400*	70†
Air dried—cu. yd.		10,600		
Analysis on dry basis		Per cent		
Nitrogen				
Average	2.45	2.00	5.0	4.6
Maximum		2.17	5.6	
Minimum		1.95	4.3	
Phosphoric Acid	0.52	0.8	2 to 4	1.9

* Approximate amount on 12 months 1922-23.
† Produced for experimental use and sold as fertilizer, estimated production would be 1,720 tons, if prepared.

ILLINOIS' FIRST BLACK BASE HIGHWAY

By Gene Abson, Chicago Paving Laboratory, Inc., Consulting Engineers, 160 N. Wells St., Chicago, Ill.

Increasing demand for better pavements on our heavily traveled highways, which will successfully withstand the effects of traffic, has led engineers to seek alternate types of construction for Portland cement concrete, or concrete bases with different wearing surfaces. Naturally they have turned toward the Pacific states and the Eastern section of the United States where black base pavements have been successfully constructed for many years with comparatively low initial cost and almost negligible maintenance expense. That this type of pavement has withstood the forces of destruction occasioned by extremely heavy traffic, has been known for years by advocates of flexible pavement design, but until this summer no real black base highway pavements had ever been built in Illinois or adjacent territory. Engineers who have confined themselves to rigid types have constantly maintained that black base could not be used in Illinois because of the soil conditions.

By "real black base" is meant the laying of the bituminous concrete foundation directly upon the excavated and rolled native subgrade, omitting any subfoundation such as old gravel or macadam, or newly laid rolled stone. Now that the "ice has been broken," so to speak, by the construction of the Brush College Road in Decatur Township, Illinois, a well-traveled connecting link, one mile in length, it is anticipated that the future will mark much wider use of flexible pavement design in Illinois and the neighboring states as a standard form of construction. It is the intent of this article to point out some of the important features attendant upon laying this type of pavement on typical Illinois silt-loam subgrade. This road is located in Macon County, adjacent to the city of Decatur.

The Brush College Road, previous to this improvement, was a narrow, worn-out gravel roadway. In reconstructing, the grade and alignment were changed throughout its length so that none of the old roadbed could be utilized in an undisturbed condition; it possessed no value whatsoever as an artificial subgrade. The subgrade, except for a short stretch of clay, is of the same character as that underlying the Bates Experimental Road and of poor load-supporting power and which necessitated somewhat greater thickness of foundation than is the practice on the West coast. Instead of the usual 3 ins. of black base with 1½ in. sheet asphalt wearing surface, it was decided to make the foundation 5½ ins. in depth with a 1½-in. top, giving a total thickness of 7 ins., which is considered superior to the standard Portland cement concrete design, or the 6-in. Portland cement concrete base with 1½-in. binder and 1½-in. sheet asphalt surface. It was not, of course, necessary to use a binder course, as the black base, composed of dense asphaltic concrete, in addition to acting as a foundation, functions also as a binder course by offering a positive means of adherence for the sheet asphalt top. On subgrades composed of gravel or old macadam, thor-

BLACK BASE HIGHWAY CONSTRUCTION ON BRUSH COLLEGE ROAD, DECATUR TOWNSHIP, ILL.
Rolling Subgrade in Foreground; First Course of Black Base in Place. In Extreme Rear, Laying Second Course.

oughly compacted by traffic, it is believed that 3 to 4 ins. of black base with 1½-in. asphalt wearing surface is equivalent in all respects to the standard Portland cement concrete pavement of 6 or 7-in. depth by virtue of its flexibility and shock-absorbing ability; while in many ways it is very much superior since it is free from the common evils due to thermal expansion and contraction, and is moisture proof.

The contractor's organization had never laid black base before, nor had the local engineers in charge of design had any experience with this type. It was only natural, then, that some features should be encountered during construction that might have been avoided through previous experience. One difficulty which was encountered was the weakness of the side forms which did not provide sufficient lateral support for this type of construction. During the construction of the base, considerable lateral pressure is exerted by the heavy rollers in compacting the hot mixture. Three methods were suggested originally, as follows, in the order of their merit:

(1) A reinforced Portland cement concrete retaining curb, flush with the pavement, about 12 ins. deep and 12 ins. wide.

(2) A header, or heel, of asphaltic concrete, tamped in place about 6 ins. below the base of the foundation, and 8 ins. wide.

(3) Three-inch wooden plank header supports, held in place with stakes, and which were to be left in place.

For the sake of economy, as the funds were limited for this work, the latter was selected, but 2-in. lumber was used, and the stakes were not set close enough together to provide uniform support. Heavy oak planks would have minimized this feature but the difference in cost between this and the curb would place the curb as first choice.

If it had been possible to prophesy that an unusual heavy rainy season would occur, the work could have been started on the opposite end from where construction began. This would have found the south end, which was all of the black loam character, completed before the rain set in and would have placed the construction of the north end in the rainy season. This north end subgrade was composed of a portion of clay and gravel which drained more readily and did not lose its supporting power when wet, as did this black dirt. Then, too, the drainage ditches over the entire road had not been entirely completed, nor cleaned, nor had the shoulders been placed and trimmed to allow normal drainage. All these factors were, of course, disadvantageous, both from the standpoint of construction and delays to the contractor. Future work of this type will doubtless find contractors paying more attention to these details, which are extremely important.

The black base itself, as was anticipated, proves to be extremely easy of construction and manipulation. All of the methods of procedure common to the usual asphalt pavement construction

BLACK BASE HIGHWAY CONSTRUCTION ON BRUSH COLLEGE ROAD, DECATUR TOWNSHIP, ILL.
Rolled First Course and Finished Subgrade Shown in Foreground. Laying Second Base Course in Background.

were followed. The same materials were used with the exception that the construction of the base in two courses permitted the use of aggregates up to 2½ ins. in size. The same plant and mixer were used to prepare the base as would be used for any asphalt paving work, and absolutely no difficulty was experienced in handling stone larger than is customary with wearing surface mixtures.

The black base mixture averaged about 4.5 per cent bitumen, 35 per cent sand and 60 per cent crushed limestone. This is somewhat less bitumen than the average asphaltic concrete binder contains, but was ample for the grading of this aggregate which, on account of its larger maximum size, offered less surface area per unit volume. An extremely dense mixture was secured by reason of the exceptionally well graded stone which compacted readily under the rollers. As mentioned previously, the base was laid in two courses, the first 3 ins. in depth and the second 2½ ins. thick. This is probably not quite as satisfactory as laying all in one course and rolling with heavy three-wheeled rollers, but which was not possible on this road as the wooden headers could not sustain the pressure. One important feature was noted here, namely, that the second course of base, in order to secure proper adhesion, had to be laid before the first course had entirely chilled. When this was not done, the second course did not always form a perfect bond with the first course, due to the fact that the large stone mixture was not capable of being forced into the surface voids and interstices of the extremely dense bottom layer. This, however, was not true of the sheet asphalt top as it adhered tenaciously to the black base. The sheet asphalt wearing surface was designed as a moderately heavy traffic mixture, and showed an average analysis as follows:

Bitumen	10.8%
Passing 200-mesh	16.2%
Passing 80-mesh	30.0%
Passing 40-mesh	32.0%
Passing 10-mesh	11.0%

On grades the filler was increased to about 22 per cent; the asphalt cement used for the black base and sheet top was identical, of 40-45 penetration.

BLACK BASE HIGHWAY CONSTRUCTION ON BRUSH COLLEGE ROAD, DECATUR TOWNSHIP, ILL.

Spreading Second Layer of Black Base. First Layer Shown in Foreground. Wagon Shown on Completed Pavement in Rear, Clearly Demonstrating the Immediate Availability of this Type of Pavement for Traffic.

It may be true that some portions may settle in time, especially over weak portions of the black dirt subgrade or new fills, but this will cause no disastrous results. Such areas as do settle can be easily and effectively patched, the patch becoming an integral part of the pavement, and if carefully done will not be discernible. This feature of flexible pavement design; that is, its tendency to seek uniform contact with the subgrade, is one of its principal assets. It appears that a logical method of road construction is to seek this end rather than at-

tempt to design a slab or beam which will indefinitely bridge over unfilled areas created by settlement of the subgrade; the latter procedure necessitates increasing the thickness of the slab with increases in traffic and decreases in load support afforded by subgrade; increasing the strength of the concrete itself has already progressed to a maximum.

In addition to possessing the quality of flexibility, black base pavements distribute and absorb the impact of traffic by reason of resiliency, thereby decreasing the possibility of subgrade failures. Black base being absolutely impervious to water, eliminates the effect of that which has been termed "moisture expansion," which though not a rapid force of destruction, may, nevertheless, be serious. The effects of frost action within the structure are also eliminated by this moisture-proof quality. One serious defect in Portland cement concrete which can not be eliminated is the result brought about by temperature changes in the expansion and contraction of the slab. The effects of thermal expansion may be evidenced by explosions, heaves or profuse cracking, and the use of bituminous expansion joints has not entirely cured these disturbances. With black base pavements, the danger from this source is eliminated.

It will be interesting to observe the measure of service given by this mile of 7-in. solid asphalt pavement as compared with that afforded by the latest design of Portland cement concrete in the road with which it connects. If an asphalt base job was ever laid under adverse conditions upon a subgrade of questionable value, surely this is the one. Advocates of rigid types have frequently made the statement that black base could not be built under Illinois soil conditions and even if this were actually done, it would not begin to approach Portland cement concrete as a serviceable highway pavement. But the construction has been accomplished under the worst conditions that could exist in Illinois or elsewhere.

A considerable portion of the credit for this project is due to the Highway Commissioner of Decatur Township, who has had implicit confidence in the virtue of black base and stood almost alone at times in the determination to see it done despite much adverse criticism.

RELATION OF CHAMBERS OF COMMERCE TO CITY ADMINISTRATIONS

By Felix M. McWhirter, President, Indianapolis Chamber of Commerce, Indianapolis, Ind.

Let me direct your attention for a little while to the contrasts of living today as against the life of only two decades ago. Twenty years ago we did not have in general daily use the automobile, the truck or the tractor, the movie, the telephone and telegraph, electricity for power (and very little used for illumination), the phonograph, and sanitation as we now know it. We have now, resulting from these discoveries and inventions—good roads, means of more quickly transmitting information, a larger potential individual earning capacity, and an easier means of living in comfort and pleasure with our families.

Yet, we have demanded more and more of government.

In the country our children must now be hauled to a most modern type of school building thoroughly equipped, over excellent roads—many of them hard surfaced—in a motor vehicle designed for the purpose—equipped so that the temperature and humidity may be just right. Last year we paid in Indiana two million dollars for such service.

In the towns we must have our streets, and even roads, lighted. They must be policed. Our ashes and garbage must be cared for. Our city streets must be paved, sprinkled and kept clean. We want parks and public grounds. We, in towns and cities, must have adequate and modern means of fire protection. All these cost money—cash money, not credit.

We have been a pretty busy people looking after our own business and well-being all the while. Most of us have produced more than we have consumed. Many have laid by either for the education of our children or for endowing our old age, or both. Most of those who have not saved, have subscribed for insurance in some form at least.

Increasing Cost of Government

Now, what has been happening all the while? Costs of government have been ever increasing, partially because of the public demand for increased service in the various manners before mentioned, and partially because of the incompetence of those charged with the responsibility of spending the taxpayers' money.

Mr. Albert J. Beveridge is quoted as

having recently pointed out that prior to the Civil War we had on the taxpayers' pay roll, Federal, State, County and Local, one employe for every 1,000 of our population, whereas during the Cleveland administration 1 was supported for every 500 as contrasted with today, with 1 for every 19 of the whole of our population. One for every five families on the average!

Taxpayers Getting Interested

If it were not on the average—if every five families supported or paid for the efforts of a single public servant in whatever capacity—do you think the five heads of households would want to know what their pay roll went for?—whether or not their employe was capable of expending vast sums of money economically and wisely? Surely they would! But too many have not realized yet, that they are paying the fiddler. But business is realizing it, the grocer, the hardware merchant of your town realizes it—the real estate owner is now realizing that he pays heavily whether he owns town property or farm lands. They are all getting inquisitive.

A Story Worth Telling

The average man used to be too much like the darky in one of Bill Herschell's stories. Bill tells of an old timer, an innkeeper, down in the hills of Kentucky, who had been elected Justice of the Peace in that little hill billy community of some nine or ten hundred souls. After some two or three weeks without a case, he one day called in the constable and looking over his specks said, "How comes no cases for this here court?" The constable replied, "There just ain't been any, that's all." The Justice of the Peace then said, "Well, I just guess that we're all going to have some court here. Get out and bring in some niggers." The constable went forth reluctantly and wound his way up to the alley end of the livery stable, climbed carefully up to the loft and eased in on a live, black crap game just as Rastus, with eyes gleaming at the two-bit piece on the floor in the center of the circle, was warming the bones and pleading daringly, "Fade dat; all or any part." There were six darkies there until the constable set his foot over the top step of the ladder, then there was one. He stopped warming the bones, his hand in mid air, as he looked up in the face of the constable, saying, "Yessir, yessir." The constable walked him into the little old hotel where sat the J. P. at court behind the single lobby table. "What's he charged with, shooting dice?'

"Yes, sir."

"Guilty or not guilty?"

"No, sir, boss, I ain' guilty. I jest couldn't be guilty. Why, I wuz just warming up the bones. I wuzn't even faded."

The J. P. leaned over, wet his fingers, turned several pages of a book, and pronounced, "I find you guilty, $22.82." Rastus saying, "Yassir, yassir," as he looked at the book, reached down and paid without a whimper.

He was released and upon joining his buddies around the corner, told them his story in answer to their anxious questioning. They guyed him and upbraided him for paying so easily. He answered with, "Who's been arrested, me or you? Who paid out $22.82? I did. And didn't I see that old Justice of Peace turning pages of dat book, and I seen what dat book was. It ain't no law book. It wuz a Sears-Roebuck catalogue, dat's what it wuz! And he wuz in the baby-carriage part. Who'd help me if he eber turned on over into the automobile section?"

Looking Ahead in Public Financing

Has it occurred to you that no bonded indebtedness should be created, even though the legal bonding limit of your community has not been reached, until after due consideration has been given to its amortization and the effect on the tax rate, present and future? No community or government obligation should be put out that does not oblige a definite fixed rate of retirement and such rate of payment should be governed by the use to which the money is put and the certain length of useful life of the improvement.

"Tax Exempt"

If a citizen of your town wishes to erect a building for commercial or apartment use, and needs financial assistance, what does he do? Can he get the use of his bank's money—can he borrow from the government? No! But he can incorporate and sell preferred stock called "tax exempt." Well it is tax exempt to the purchaser because the borrower must pay the taxes. To pay 6 per cent tax exempt, the borrower must earn 10 per cent at least on his realty, and net of all expenses—so, we find high rents. Then we have the state, the county, and the city in competition for money, men and materials,offering 4, 5 and even 6 per cent for money and tax exempt, too, both to the loaner and the borrower.

If all of you would enter into a municipal program of improvement at the same time, and that program for completion in two years, say—what would result? You would grind out more tax exempt securities in competition with business, yes—but unfairly, too—for you would employ workmen needed in productive work, pay interest on the money so expended for the balance of their days. In 1882 Marion County, Indiana, built a court house and to this day $400,000 of its cost is still unpaid—just interest, interest, interest.

How the Chamber of Commerce Can Help

But why a Chamber of Commerce, and how can it help you in municipal government? If the business men of any community all want the same thing for their city at the same time, they generally get it—but is their goal a proper one, have they studied it from all angles? Too many times some want this or that just while others are sure that the present municipal undertakings are deplorable. A Chamber of Commerce is a voluntary organization, born with one sole underlying purpose—the common good. It is supported by citizens zealous for the community good, all interested in its commercial, industrial and civic development. A Chamber of Commerce supplies a continuity and a persistency of effort. Sustained effort is set in motion only after facts have been obtained and possible methods of procedure canvassed. A thorough study is made by a committee which submits its findings by recommendation to the Board of Directors for approval. If they approve, it then becomes a commitment, the lasting duty of the executive officers and paid staff to persist to the end that there is accomplishment.

Where the Average Citizen Gets Action on His Ideas

In the past, one of the greatest drawbacks to municipal development has been the fact that the average citizen took no interest and very little if any active part in the administrative affairs of his city. The feeling of helplessness on the part of any individual is soon dispelled if it is possible for him to place his suggestions or criticisms before a responsible organization that will carefully analyze and ascertain the facts and merits.

Almost daily, the Indianapolis Chamber of Commerce has occasion to support the efforts of some department of local government. There are times, too, when we believe that we have helped constructively. Rarely is it necessary for us to criticise. Our effort is to work with the administration for the common good.

Helping the Public Official

When a man goes into public office and especially where the affairs of a city are left to him, we presuppose that he is a man of affairs, intelligence and with sane ideals. Is that man to go ahead with a program which would be within his own power, and assisted only by his co-workers in the carrying out of that program? Or is he going to ask his assistants, through the particular departments concerned, to take up the proposed plan with the Chamber of Commerce, get the opinions of experts, have them place the plan before their working committees, or get them to appoint a special committee, and more than that to let the public generally learn by public expression from the Board of Directors of the Chamber of Commerce that the program is a proper one and to be supported?

Co-operation With Chamber of Commerce

Why does he wish co-operation from his Chamber of Commerce? Because of his faith in the town in which he lives, because of faith and confidence in his civic organization. He knows that the Chamber of Commerce is ever on the alert to lead or to assist in anything for the good of the city and the people in it. Civic activities are those which promote public welfare and benefit the community. The apathy of previous years has given way to interest, and among the more progressive, to a very active interest in studying and molding city conditions. A thriving, steadily growing town, village, or city is a better place to live in and to work in than one just keeping up or lagging behind.

Business Men Can If They Will

A mayor of an eastern city once said that there is no body of men in any community that can exert a greater and bette influence for the public good than the business men, if they will. They have proved it on many occasions and they can and will again show their power for good whenever the occasion arises. If a Chamber of Commerce is going to work with the city administration and bring the best out of the men in the city's service, the people of the city must evidence their appreciation of the faithful work of the men of the city administration.

Even a child can be "more than a voter" to an extent too little appreciated by most of us. But look at the splendid

attitude of our present city administration in Indianapolis and what they are doing with and for our children! The organization of traffic squads throughout the various schools in Indianapolis is just another step forward. They are being organized along the same lines as our Traffic Department itself—it is an education to the children in the government of their City and it is an excellent illustration of "Safety First" in addition to imbuing them with a feeling of responsibility for their neighbors.

The modern Chamber of Commerce parallels the municipal and county governments—not for purposes of criticising—no—but to lend that experience of fact which has operated successfully in local community affairs, or in affairs of other localities.

The foregoing is from an address by Mr. McWhirter before the 1923 Convention of the Municipal League of Indiana.

THE TEST HIGHWAY AT PITTSBURG, CALIFORNIA

By Lloyd Aldrich, Mem. Am. Soc. C. E., Consulting Highway Engineer, Merchants National Bank Bldg., Los Angeles, Calif.

The need of additional technical information for solving many problems involved in the building of durable highways is keenly felt by engineers, and the interest of the public who furnish the funds for improvements is scarcely less keen. Appreciating this situation, and also believing that a grade of steel that it could manufacture would aid in improving results under difficult construction conditions, the Columbia Steel Co. was prompted in February, 1921, to undertake a highway research at Pittsburg, California.

While this type of investigation was new to this Company, like other corporations they were accustomed to undertake research. The Company placed this work in charge of the writer with John B. Leonard, structural engineer, as associate, with instructions to make it thorough and to collect all data practicable that would add to or confirm present information, and to invite cooperation from all who would take an interest in such an engineering study. These were the only instructions the Columbia Steel Co. ever gave but their co-operation was always in evidence and they consistently paid the bills. As the material in which the Columbia Steel Co. was interested was a special bond, high elastic limit open hearth reinforcing steel (not patented), the test naturally became one of Portland cement concrete pavements.

Outline and Object of Tests

The intention was to secure information on the relative merits of enough different types of pavement, including types embodying the ideas of the Columbia Steel Co., to enable engineers to design highways with greater certainty of results. To insure construction methods that would parallel those used on actual highways, only those already found practicable in the field were adopted. It was one objective that this test would represent to the fullest extent the ideas of engineers and officials actually engaged in highway construction.

The plan was for a track of two tangents, joined with semicircles and wide enough to permit two lines of travel. The foundation for the pavement was on adobe fill, since such soil, which is found in certain locations in the western and southern states presents, particularly under fill conditions, one of the most difficult construction problems. The complex action of adobe, particularly under variable moisture conditions, is a source of trouble and failure. It was intended to investigate the efficiency of both plain and reinforced concrete pavements of variable thickness and design on such subgrade. The effect of the expansion and shrinkage actions of adobe subgrades due to variable moisture content, on pavements was to be given special attention.

Professional Assistance

The selection of designs to be used became an important question. It was considered vital that the designs should represent the ideas, as far as possible, of the engineers engaged in highway construction. Accordingly a questionnaire was sent to all California engineers who were understood to be interested in this class of work. Many designs were received, frequently with supporting arguments more complete than could be conveyed by merely answering the questions. The sentiment was unanimous that the test should be conducted on adobe soil.

As a result the program adopted included 13 types of concrete pavements. Of these, three, Sections C, D and L, were designed by the Columbia Steel Co. All of the other types are the result of the questionnaires and designs of various engineers.

Commercial Assistance

Upon their own responsibility the engineers in charge submitted an outline covering the various features of the undertaking to several commercial firms interested in road building and asked for their assistance. Encouragement and support from these interests followed in an unexpected degree.

Construction

A location fulfilling the desired conditions was secured on the outskirts of the city of Pittsburg, through the kindness of Mr. W. E. Creed, president of the Columbia Steel Co. It had been used only for farming and was at the time seeded to grain.

One of the leading highway contractors of California built the test road, under specifications and engineering supervision, and with a crew and grading equipment that had been engaged on a contract in the interior of the State.

The construction of the tunnels and grading was started May 1, 1921, and completed June 28, 1921.

Concreting commenced June 29, 1921, and was completed July 11, 1921. The plant for the concrete work was loaned by dealers and operated by the contractor. The device for placing the reinforcing steel was designed and furnished by the Columbia Steel Co., and proved to be very satisfactory.

Observation Tunnels

An important feature of the test was to be a study of the stresses to which concrete pavements are subject, especially stresses of flexure. Since the usual strain gauge procedure for measuring stresses on the surface of concrete is largely for static load conditions, which are not completely representative of the action of the highway, it was desirable to supplement this method to include the action under moving and impact loads.

Direct observations of the normal action of pavement under moving loads could only be obtained from the under side of the pavement. Tunnels were accordingly built under Sections B, D, G and I at such depth that there was sufficient earth between the roofs and the bottom of the pavements to insure normal action. The tunnels were as narrow as permissible to permit observations and extended across the entire section of the pavement into the tunnels with the upper ends cast into the concrete. By means of delicate instruments the slightest movements of the rods could be observed and recorded under any loading. Another similar set of rods was installed for studying the action of the subgrade. The upper ends of these rods were fastened to flat plates resting on the subgrade directly under the pavement. The lower ends projected into the tunnel for corresponding observation.

Level Observations

Level observations begun Sept. 28, 1921, were expected to yield information regarding the action of the adobe under variable moisture conditions. A few days showed movements of the pavements that could hardly be accounted for by any reasonable action of the subgrade. It was apparent that a more accurate and intensive study of these motions was essential.

Temperature

Movements of the pavements due to changing temperature were originally expected to be horizontal, so an extensometer with a ratio of about 60,000 to 1 was provided for their measurements. Careful observation soon clearly indicated vertical pavement movements that were continuous and probably the result of variable temperatures. Correlation of the rate of change of temperature of the concrete in the pavement throughout its thickness, with closer observations of the vertical movements showed that these movements were caused by variations of temperature.

Crack Record

The visible effects of traffic on the pavements were noted by crack records, which required the daily plotting of all cracks as they appeared, and also of distintegrated areas, on specially prepared drawings to scale. For this purpose the entire track was painted into 6-ft. co-ordinate squares, so that the location of each crack could be readily plotted. The crack record also shows the dates on which cracks occurred and their extent and so shows very accurately the history of the behavior of these pavements.

Ditches and Moisture

Ditches built on each side of the road could be filled with water from an elevation below the base of the new fill to the elevation of the bottom of the pavement. Thus moisture conditions could be made to correspond to a rainy season or to a condition that too frequently occurs where irrigation exists. Equalizer pipes built in the grade insured the same water elevation on each

side of the road. As it was expected that the investigation would be completed before the California rainy season, water was piped to the test.

On Dec. 21, 1921, the ditches were filled with water to the elevation of the bottom of the pavements. This water level was maintained in the ditches until the traffic was discontinued, Jan. 30, 1922. However, the water was not drained away until the middle of March, 1922. It was anticipated that with the ditches full of water the grade would soon become saturated and the destruction of the pavement accelerated. The rains were also expected to contribute very materially to this result. This opinion seemed to be shared by visiting engineers who had experience with adobe under such conditions. The result did not meet the expectations. Only a very small amount of additional moisture was taken up by the grade. The moisture determinations of the borings indicated that beyond a lateral distance of 2 ft. from the water the absorption was very small. The resistance of the grade to moisture penetration can be attributed to the manner in which it was built.

Tunnel Observations

The first study in the tunnels was of the action of the pavements under truck loadings. A Standard truck equipped with solid rubber tires, loaded with pig iron till gross weight was 7¼ tons, was used throughout the investigation.

Observations were made for static, moving and impact conditions of this truck before regular travel was started, and also one day each week during the entire traffic period.

The deflections* of the pavements under static conditions were determined for three selected positions along the line of travel—one at each side of the track and one on the center, and in a few cases two trucks, both loaded as was the test truck, were used.

The moving truck tests required the truck to travel twelve miles an hour, over the positions of the static tests. It was found that the deflections for this condition were less than those for static loading.

The impact tests were made by passing the truck over a triangular strip of board, causing a vertical drop to the pavement directly over the pavement rods. The speed of the truck in this test was always twelve miles per hour. The position of the impact board was determined by trial so that the point of the initial blow from the rear wheels would be on the line of the tunnel pavement rods. The positions of the impact tests were the same as those for the moving and static observations.

So far as could be determined, there were no cracks in the pavements over the tunnels caused immediately by 236 impacts of the truck in these special impact tests.

Traffic

Traffic was started Nov. 9, 1921, in two lines moving in opposite directions. These two lines were continued until Dec. 24, 1921, when, due to broken conditions of some portions of the track they were changed to a single line. The single line was continued until Jan. 29, 1922, when traffic was suspended until June 1. When the second period of traffic was begun on June 1, 1922, the pavements had been thoroughly repaired and travel was again in two lines, and so maintained for the balance of the test. Traffic was finally discontinued on July 27, 1922, with an intermission between July 1 and 24. For a short time during this second period traffic was also started between 4 and 5 o'clock in the morning, when the edges of the pavement were "curled up." Gross loads were also increased during the test from a uniform load of 7½ tons to loads in some instances as great as 13½ tons.

The U. S. Bureau of Public Roads and the California Highway Commission each supplied 20 trucks, and the California Highway Commission furnished all of the drivers. The daily average of trucks on the track was about 32 as long as the double lines of travel could be maintained. This number of trucks was determined to be the best for passing the largest tonnage over the track each day, as more trucks tended to retard the speed of all, thereby reducing tonnage. When it was found necessary to reduce the travel to a single line, the average was about 19 trucks. A speed of about twelve miles an hour was maintained throughout the tests. It was soon found necessary to give the drivers a 15-minute rest in the middle of the forenoon and afternoon, as four hours of continuous driving of this character was more than could be safely driven. There was thus 7¼ hours of travel each day and this

*Deflections first became manifest when the truck was about 15 ft. from the axis of the tunnels.

schedule was maintained six days of the week. The day that travel was suspended was utilized for making tunnel tests.

Upon the completion of the truck travel test on July 27, many of the sections were still in serviceable condition.

These sections were subsequently subjected to an excessive moving load on a trailer, which could be loaded to 50 tons on a single axle. The tires of each wheel were two 5-in. steel bands. The first load was 15 tons on the axle.

There were a few accidents during the operation of the trucks. Only one, which was serious, but not fatal, occurred during the test and that was to one of the drivers while parking the trucks at the end of the day's run.

The 18-ft. width of roadway was soon found to be as narrow as could be used with the two lines of trucks with complete safety. Even with this width, expert drivers would sometimes run off the tangents as well as the curves.

When the rains started, the adobe sticking to the wheels of a truck that had been off the track soon formed a slippery coating on the pavement that caused much trouble. Under this condition a deep rut was soon formed at the edge of the pavements for a considerable portion of their length. Efforts to keep the track clean were ineffectual, even for a few hours, and the distrust of the drivers increased. This obstacle to traffic was so serious that its correction became imperative. Trenches on both sides of the pavement were made throughout the length of the track and filled with ballast of old furnace brick. These trenches were made by running one of the rear wheels of a truck along the edge of the pavement, which operation made a depression the width of the tire and about 1 ft. deep. All of the drainage of the pavement during the major portion of the winter or rainy season ran to these trenches. A few run-offs to the side ditches were dug, but they were sufficiently frequent to insure only a very moderate drainage.

The ballast was allowed to remain in position during the remainder of the test. It was compacted somewhat by trucks getting off the track but undoubtedly permitted a much freer circulation of air at the edges than would have existed if the trenches had been filled with earth.

Repairs to Highway

No attempt was made to maintain the track during the traffic period, with other than temporary repairs. These were made with the sole object of avoiding the interruption of the travel without affecting the strength of the pavement. During the early part of the traffic a mixture of adobe soil and crushed rock lightly sprinkled with water was used. This method had to be abandoned during the rainy season and a more substantial construction adopted. One such method was to lay two courses of 2-in. plank at right angles to each other and on them a course of building brick. The building brick was then covered with 2 ins. of penetration macadam. Fairly good results were thus obtained but in some cases it was found advisable to use a heavier construction. A layer of 12x12-in. timbers 8 ft. long were accordingly laid normal to the axis of the pavement and on them were laid, transversely and longitudinally, two courses of 3x6-in. timbers. These were covered with a $\frac{5}{8}$-in. steel plate. In a few cases precast slabs were used instead of the timbers. During the June and July traffic of 1922 an oil macadam was used for maintenance purposes. Repairs were promptly made during this period so that the double line of travel was continued without interruption.

Subgrade

The adobe soil at Pittsburg, which was ploughed, scarified, pulverized, sprinkled and rolled in 6-in. layers, as previously described in the construction of the test road, was sufficiently impervious to seeping waters from the flooded ditches to maintain a compact and suitable subgrade. The ditch water standing on each side of the road for about three months did not to any extent penetrate the adobe. Moisture soil samples taken from the shoulders 3 ft. from the edges of the pavement and also from under the pavement showed a very small change in moisture content for this period. The expected characteristic heavy cracking of adobe soil was not as extensive on the shoulders or on any part of the soil that had been prepared and rolled as above indicated. The swelling and shrinking action of adobe, where the soil was not treated at the test highway, is, however, evident, but no evidence of such action was detected in the soil over any of the tunnels. The base line pens in the tunnels did show a slight lowering of the pavement but the rate was approximately constant. No vertical

fluctuations in the pavements due to the slightly varying percentages of moisture could be detected.

This method of preparing the adobe soil for the subgrade involved a relatively small additional expense over present practice and warrants further study of such roadbeds, which occur under actual conditions. It may develop that soils which have heretofore caused so much trouble for highway engineers may thus be made into an excellent subgrade.

Surface Wear

The heavy rubber-tired truck traffic put over the unsurfaced concrete pavements did not cause any surface wear. White lines painted on the pavement in 6-ft. squares so that the cracks could be plotted with facility were never effaced although frequently, during the winter, layers of soil were deposited on the road by trucks that ran off onto the earth shoulders, and these layers were removed by scraping irons and by sweeping. At the end of the January traffic the white lines showed plainly except in a few small areas where the surface had been ground off by the screenings picked up by the rubber tires from adjacent repairs. The lines were, however, dirty from the frequent deposits of soil and it was decided to repaint them for the June travel. Close inspections of numerous portions of the pavement that were on the lines traveled by the truck wheels yielded no evidence of diminution of distinctness of the finishing tool marks as the test progressed.

But a very limited metal-tired travel showed a surface wear that would be destructive. The two-wheel trailer with 10-in. wide steel tires was operated over the road for several circuits with a 15-ton load, and it was clearly apparent that this load on steel tires broke any small irregularities with the first passage of the trailer and with each succeeding passage additional surface destruction followed.

Traffic

It would be desirable to express the 7,362,000 tons of traffic that passed over this test road in terms of years of service of a highway if that were possible. This problem involves assigning limiting values to conditions based on individual judgment and experience. Consequently, results will differ.

The tonnage of the Pittsburgh test was confined exclusively to heavy trucks. The lightest was 7¼ tons and the heaviest 13½ tons.* The application of these loads was very much accelerated as compared with conditions that exist on the public roads; the intense duty of the test road is indicated by the fact that during one day's traffic of 7½ hours, there were practically 5,000 trips on each line of travel, making, when double lines of trucks were operating, a total of 10,000 daily trips. When traffic was confined to a single line on account of broken areas in the pavement, only 3,500 daily trips were made.

Deflections Under Traffic Loads

The excellent condition of the track at the end of the scheduled traffic test made it desirable to apply an ultimate destructive test and a 50-ton axle load which gave a pressure of 5,000 lbs. per lin. in. width of metal tire was applied and produced structural failures in five of the 13 sections, A, B, H, I and L. The remaining sections showed that they were able to carry this load satisfactorily. The weaknesses of these five sections, however, made it impracticable to continue this test. The deflections of rods No. 9 were noted under a 7¼-ton truck traveling 12 miles per hour with the outer wheels passing over rods No. 9. These rods were practically in the direct line of travel of the outer wheels of the trucks during the period of double-line traffic.

A summation of these deflections is of interest and possibly significant. However, the results are not all strictly comparable because of the difference in temperature at the times the observations were made. If the temperature conditions were assumed constant during a day's run the results would show that rods No. 9, in this period, had a total accumulated downward movement as follows: Tunnel B, 12 ft, 1 in.; tunnel D, 6 ft. 3 ins.; tunnel G, 9 ft. 7 ins.; tunnel I, 5 ft.

There were no cracks in the pavements over the tunnels at this time, so that these deflections represent the elastic actions of the slab and subgrade. This calculated daily total downward movement is based upon assumed constant difference in temperature between the top and bottom fibers of the pavement. For the variation of this tem-

*Loads heavier than these were used in special tests.

perature difference various conditions can occur. This data is submitted for the purpose of illustrating the type and magnitude of actions that exist in the edges of pavements under traffic conditions.

The amount that the subgrade contributed toward temperature deflections is uncertain, due to the possibility of a loose fitting of the plates on the upper ends of the soil rods, which condition was found in a few instances. But the soil deflection readings uniformly indicated that such deflections rarely extended from the loaded edge beyond rods No. 5.

The repairs between January and June included two new sections each 30 ft. in length, over tunnels B and I, in which the soil rods were placed so that there would be no question as to the reliability of their action. The subsequent deflections of both soil and pavements showed that soil rods No. 5 did not register deflections. The elastic action of the subgrade was apparent in all soil-rod observations. Whether soil return from a deflected position follows the same law as that indicated by the pavement rods is not known.

Under the concentrated traffic in this test, there is no question that the slab recovery between loadings was considerably less than complete. Investigations showed that hours were required before the pavement and subgrade returned to normal position from their strained condition. Whether the successive deflections from the normal position due to the application of loads at very short intervals were increased beyond the original deflection due to the first applied load was not determined. These subsequent deflections could not have been less than the initial deflection and if they were greater this fact may influence the breaking of pavements of uniform thicknesses at the edges. Such action would doubtless be most pronounced at the corners and edges where transverse cracks have occurred since those portions are weakest. With a faulty subgrade there is doubtless increased deflection. In some of the cases deflections appear to increase as the traffic test progressed. In interpreting these cases care must be taken to include influences of cracks, temperature changes and loading.

The night and early morning period,

COMPARATIVE PAVEMENT RATINGS, JUNE 30, 1922. TRAFFIC OVER TEST HIGHWAY TO JUNE 30, 6,914,850 TONS

Section	Cubic Yards of concrete per mile as actually laid	Tons of steel per mile	Total broken areas in square feet per square yard of pavement	Total lineal feet of cracks per square yard of pavement	Computed original cost per mile of pavement only	Theoretical maintenance cost per mile	Percentage of failure	Total computed cost maintenance plus original cost per mile	Unit comparison of total computed cost per mile
J	2,110	....	0.07	1.44	$31,439	$ 885	2.8	$32,324	$1.000
D	1,845	55	0.36	2.01	33,271	4,205	12.6	37,476	1.159
C	1,798	55	0.45	2.56	32,549	5,152	15.8	37,701	1.666
K	1,722	69	0.53	2.66	32,643	6,049	18.5	38,692	1.197
F	2,719	....	0.00	1.11	39,426	117	0.3	39,543	1.223
M	2,574	....	0.22	0.70	37,323	2,810	7.5	40,133	1.242
E	2,806	....	0.00	0.60	40,687	63	0.2	40,750	1.261
G	2,127	69	0.56	2.04	37,902	7,291	19.2	45,193	1.398
L	1,740	55	1.56	2.29	31,659	16,705	52.8	48,364	1.496
B	1,590	20	2.99	3.91	26,207	26,534	100.0	52,741	1.632
H	1,760	24	3.09	3.91	29,176	30,464	100.0	59,640	1.845
I	1,953	24	3.12	3.01	32,139	33,743	100.0	65,882	2.038
A	1,834	20	4.08	3.74	35,427	48,576	100.0	84,003	2.599

(a) All pavements 18 ft. wide.

(b) Estimated Cost—

Unit costs of plain concrete as follows:

From 1,001 cu. yds. to 1,500 cu. yds. per mile, $15.75 per cu. yd.
From 1,501 cu. yds. to 2,000 cu. yds. per mile, 15.35 per cu. yd.
From 2,001 cu. yds. to 2,500 cu. yds. per mile, 14.90 per cu. yd.
From 2,501 cu. yds. to 3,000 cu. yds. per mile, 14.50 per cu. yd.

Cost of reinforcing steel, $90 per ton in place.

Cost of rock ballast under Section A, $5,475 per mile..

(c) Cost of maintenance of cracks assumed equal to 1 ct. per lineal foot. Unit maintenance costs of broken areas are assumed to be three times the original unit cost of the pavement only.

(d) Percentage of failure determined from ratio of sum of maintenance cost to original cost. Those cases where maintenance cost exceeded original cost, percentage of failure is 100.

from 9 p. m. to 7 a. m. showed deflections of the edges greatly increased over those caused by day travel, since prevailing lower temperatures raised the edges of the pavement from the subgrade.

The condition of the track at the end of June was good, due to the increased care given it during the June period. However, throughout the test all sections were treated alike with respect to maintenance.

The ratings of the 13 types of pavements have been indicated on several bases, including estimated construction cost. (See accompanying table.)

The expense of tarring cracks was assumed in all cases as 1 ct. per lineal foot; the cost of making patches was estimated at three times as much as the original pavement cost per unit of area. In this table in the column, "Maintenance Cost Per Mile," it will be noted that section M shows a very much larger maintenance cost than Sections E and F. This is explained by the fact that, although Section M had two large corner breaks, they were caused by the impact of traffic from a break in the adjacent Section A. This condition was general in all sections that had broken areas. The exact area of breaks in each section, resulting from the above cause, was difficult to estimate; therefore, the entire broken area in each is considered in compiling this table. By this method a pavement that had involved a maintenance expense that was equal to its original cost would be rated as a total failure even though some portions of it were still in use. This table shows that percentage of failures do not necessarily indicate the most economical pavement. Section J is a type of pavement in use by Maricopa County, Arizona, at the time this test was planned and it was included at the request of the officials of that county. The design was previously used, however, by the California State Commission and was first built by them. Submerged curbs were, however, used in Wayne County, Michigan, in 1910.

It is probable that the same amount of concrete required for this section, if laid in the form of the usual flat pavement, would have given less satisfactory results. Doubtless this section transmits loads advantageously to the subgrade. No section of this type contained reinforcing, so that data is lacking to decide whether it would prove beneficial or not. The weaknesses that Section J developed were not characteristic of those reinforced sections and defects of the reinforced sections did not markedly appear in J, for the longitudinal cracks of J were not characteristic of the other sections where transverse reinforcing was present. The strength of the edges of the reinforced types was manifestly inferior to that of Section J. It remains for a future test to prove whether reinforcing will be as beneficial to this design as it was to the sections of uniform thickness.

A direct comparison of plain and reinforced pavements of equal thickness is not established but in relative values computed for B and K is an indication of the effect of increasing the reinforcing and placing so as best to resist tension stresses. For this comparison, Section B should be considered as a plain type so far as flexure is concerned, for the steel contained in it was placed in the middle of the pavement and therefore could be of no value in flexure until the concrete had cracked. Immediately after cracking under this condition, it has a strength as a reinforced member equal to 40 per cent of the original section on the basis of 350 lbs. per sq. in. as the modulus of rupture of the concrete and 32,000 lbs. per sq. in. as the elastic limit of the steel used in this pavement. In the case of the reversal of moment which the deflection observations clearly show exist, the compression and tension areas are interchanged, resulting in a pavement cracked its full depth. The steel, due to being placed in the center, was unable to offer any resistance to the formation of these cracks.

Section A was built like Section B, but rested on a different (broken stone) foundation and this foundation of Section A is considered largely responsible for its early failure. It was the only section in which breaks started in the middle. In all the other sections, all of the breaks started at the corners, ends and edges. While Sections H and I are of the same thickness and contain nearly the same amount of steel as Section A, both have longitudinal joints in the middle and Section I has an edge curb in addition.

In computing the table the actual thickness of the concrete as found from the cores removed and by measurements

on braking up the slabs in February, 1923, was used throughout.

Transverse Cracks

Vertical temperature deflections of the edges of Section D show that they moved in a wavelike manner. This is attributable to two causes which may in some degree act independently but under most conditions are jointly present. One of these conditions is the unequal expansion of the extreme fibers of the concrete because of their difference in temperature. The other is the existence of an axial stress caused by the longitudinal expansion of the entire section and the frictional resistance of the subgrade at the bearing points. A third condition which is induced by these two is one of flexure.

The stress in the concrete will be a maximum under a combined action of the axial and flexural forces. The ratio in which these two forces act can not be stated, but in many cases the flexural forces may be suspected of being the predominating factors.

Effect of Traffic on Corners of Plain and Reinforced Concrete

The action of those corners of reinforced sections that broke, due to traffic, is particularly worthy of note. Since the steel added a very small value to the flexural resistance of the concrete before cracks appeared, as in all reinforced concrete construction, it was only after a crack developed that the steel could function as intended. The increased traffic that was carried by a cracked reinforced corner compared to a cracked plain concrete corner was very marked. Whereas the plain concrete corner continued to disintegrate under repeated applications of load until completely gone, the elastic properties of the steel so supported the reinforced corner that disintegration was considerably retarded. The corner referred to sustained 46,500 applications of truck loads of 23,800 lbs. from the time it cracked to the end of the traffic test. This was a corner of the repair section 30 ft. long, placed over Tunnel B during the suspension of traffic. This section is shaped similar to Section J but is a 5-in. pavement, thickened to 8 ins. at the edges. All reinforcing bars were ⅜ in. Round corrugated and transverse bars were placed on the top at 9-in. centers and on the bottom at 12-in. centers. Two bars on top and two on the bottom were placed longitudinally along each edge of the pavement. The corners were additionally strengthened by three short longitudinal bars at the edges, and by two transverse bars, all in the top of the pavement.

The foregoing article by Mr. Aldrich was written out for "Municipal and County Engineering," and was based on an impromptu talk before the recent annual meeting of the League of California Municipalities.

DESIGN OF CAR TRACK FOR PAVED STREETS AND MAINTENANCE OF THE PAVEMENT

By Howard H. George, Engineer Maintenance of Way, Public Service Railway Co. of New Jersey, Newark, N. J.

Engineers will acknowledge the impracticability of preparing a definite specification for street railway track construction which would be suitable for all possible conditions. Neither is it desirable to set up one, two or three types as standard and say to the railway industry: "Use this type here, or that type there." Such a specification or standard design would work an unnecessary financial hardship on a large percentage of street railway companies, and would probably not give the best results to a great many others who were financially able to build in accordance with it. And not only must economy in first cost be considered, but economy in subsequent maintenance as well. And, last, there is still the fact to face that track wears out and must be completely rebuilt and it should be so designed in the first place as to permit the maximum amount of salvage at the time of reconstruction. This feature is equally desirable in the case of pavement. This is an item which is apt to be frequently disturbed during the life of a track, and the cheapest in first cost is often the most expensive in the long run.

Standard specifications for the miscellaneous materials entering into a track can and should be prepared, but to say that any given combination will result in the best track for all conditions would be about as ridiculous as to say that there is one best automobile or one best anything else that is manufactured by assembling a number of different units together. The experience of others is a good guide as to what may be expected from any particular type of construction, but this experience should be determined from careful personal observation and not from camouflaged reports.

Factors to Consider

Street railway engineers are confronted with a very large and important problem in the determination of the type of track construction most suitable for the conditions on their property. Several factors enter largely into this question. Probably the first is the maximum weight and type of equipment to be operated and volume of traffic to be carried.

The next factor is that of the condition of the soil on which the track must be placed, and its ability to support the loads. This subject, together with that of the actual stresses existing in the track, is one to which, unfortunately, too little attention has been paid in many cases in the past, and has undoubtedly been responsible for many cases of failure of the track structure and consequently of the paving. Soil which, under ordinary or natural conditions, would be entirely unsuitable for supporting any kind of track structure, may be made entirely satisfactory in several different ways. It may be accomplished by the use of cinders or other light, porous material rolled into the soil so as to form a binder. Sometimes crushed stone or slag will best answer this purpose, and in the latter case it may be that the run of the crusher will accomplish the best results rather than the use of a uniformly graded ballast. Then again, conditions may be such that drainage of some kind or another should be resorted to. The existence of storm water sewers in the streets has, in many cases, a very large effect on the condition of the sub-surface soil.

The last important factor is that of economy, and it is in meeting this requirement that the engineer is called upon to exercise his greatest ingenuity and is largely responsible for the many different details of track construction in use by electric railway companies in this country today. One engineer will advocate stone ballast. According to his idea 6 ins. of such ballast should be placed under the ties. Another engineer, while agreeing that stone ballast is the proper material to use, will say that 4 ins. under the ties is sufficient. Still another engineer will say that just as satisfactory results are obtained by the use of gravel, crushed slag, or perhaps cinders for this purpose. Probably all three are obtaining satisfactory results, and it is here that local conditions play a very important part. In one locality crushed stone may be scarce, it may have to be hauled a long distance, while gravel is obtainable locally at a low cost. In the other case, it may be that good cinders are obtainable, whereas neither stone nor gravel are to be had at a reasonable cost. Or it may be that the natural soil condition is such as to make it unnecessary to use any other than the natural soil for ballast.

In the matter of ties, some engineers specify white oak ties because they can still obtain them locally, or within a reasonable distance of their property. But it would be out of the question to require every property to use white oak for this purpose, for it could not be obtained in sufficient quantities at any price. There are plenty of other woods which answer the same purpose for electric railway track conditions equally as well at considerably less cost. Many otherwise inferior classes of woods are made entirely suitable for railway ties by the use of a proper preservative treatment.

The use of tie plates may or may not be necessary or desirable. This depends entirely on the weight to be carried by each tie, and the compressive strength of the wood at right angles to the fiber. If the rail base and the tie at the rail bearing point are wide enough to provide a bearing area sufficient to keep the unit compressive stresses within the proper working limits and prevent excessive cutting during the life of the tie, then tie plates are not necessary, and their use adds nothing to the life of the track and only serves to increase its cost.

As to the question of rails and joints, we are again confronted with a large assortment from which to choose. Heinz with his "57 Varieties" has nothing on us when it comes to selecting a rail, and the worst of all is the fact that the rail manufacturers are apparently willing to continue to make new sections as often as a railway company with sufficient influence makes a request for one, sometimes making that company pay for the cost of the new rolls, and sometimes absorbing this cost in its general manufacturing overhead. In many cases the differences between rails are so slight as to be hardly noticeable. Here again weight of equipment, volume of traffic, design of wheel treads and flanges, as well as details of the track structure must enter into the discussion. I will not attempt to express an opinion of the relative merits of the various types of

rails, either as to details of design or on what are ordinarily referred to as T-rails, as compared with what are commonly known as Girder rails, as this is a subject that would start an argument which would in itself take up more time than is available at this meeting.

It is generally admitted that street railway engineers are divided into two camps, one of which advocates a rigid track structure; that is either steel ties encased in concrete or some form of concrete beam support, while the other advocates an elastic or resilient supporting structure for their rails. While I have some very decided views on this subject, I will refrain from discussing the relative merits of the two types, for this would again open up a field for argument which has no place in a paper of this kind.

Type of Paving

A concrete pavement in a track area can be put down at a very reasonable figure, and when it is first laid it looks fine. But unfortunately rails have a peculiar habit of breaking occasionally, joints go bad and the concrete has to be taken up in order to make the necessary repairs, and it is almost impossible to make an entirely satisfactory repair job on concrete paving. In addition, when the time comes to entirely rebuild the track, the salvage on the paving is practically nothing.

Brick and wood block pavements both have found considerable use in track areas, but while more economical in first cost than granite, and although under some conditions giving satisfactory results, in the majority of cases they are not the most satisfactory pavements for track areas, and economy in first cost is very often responsible for subsequent expensive paving maintenance and practically no salvage value at the time it becomes necessary to entirely rebuild. The same statement is true for asphalt paving, and especially where the asphalt has been laid in direct contact with the rails. Experience has shown that, where asphalt paving is laid in the track area, at least one and preferably two or more rows of stone block should be laid on each side of the rail. There is always some vibration of the rail and where the asphalt is laid in direct contact with the rail this vibration opens up a small joint between the rail and the asphalt into which water penetrates and the action of the vehicular wheel loads on the pavement at this point soon disintegrates the asphalt immediately adjoining the rail.

Stone block pavement on the other hand, while costing more in the first place, lends itself readily to repairs, has a long useful life under the most severe traffic conditions, and after years of service can generally be reclipped and relaid at a relatively small cost and gives a pavement as good as new. As a matter of fact old blocks which have been reclipped should make a better wearing and more dependable pavement than new block, because of their previous long exposure to the weather, and the fact that in this way all soft stone has been eliminated.

Effect of the Other Utilities on Track Maintenance Problems

If no other utilities occupied the streets the problem of track and paving maintenance would be much simplified. The problem of the location of the various utilities in the public streets becomes more complicated every year, not only to the municipal engineer but those of the utilities as well. The street railway, as one of the utilities, is the only one which occupies the surface of the street. In addition to the street railway there are no less than six other utilities which may occupy the streets in some manner.

We have sewers, water, electricity, gas, telephone, steam mains and sometimes mail tubes, all of which occupy more or less space and require frequent service connections to the adjacent structures along the street. Some streets also carry exceedingly large trunk sewers and water mains which are frequently independent of the regular local mains. Practically all of these utilities have manholes and valve boxes which extend to the surface at frequent intervals and these often form quite a collection at street intersections. Instances have been noted of as many as eleven manhole covers at one location within the confines of two 50 ft. intersecting streets. When there are many manhole heads in the vicinity of the car track, curves and special trackwork, it becomes a nice problem to design tracks to dodge them, and their presence usually causes great difficulty in properly constructing and maintaining the tracks and track pavement.

There is a need for closer co-operation among municipal and utility engineers in relation to matters of location, and many cities are finding it very desirable to set up bureaus charged with the design and location of sub-surface structures.

The construction of sub-surface utilities prior to the construction of street railway tracks of a permanent character is greatly to be desired, and until the streets are properly graded, curbed, paved and have all their normal underground sub-surface mains in place, it is not desirable to attempt to construct tracks of a permanent nature. The sidewalk spaces might be more generally used for locating many utilities, although in some places there may be objections from a legal viewpoint relating to the use and occupancy of such spaces. And, of course, vaults under the sidewalks occasionally cause some trouble. My understanding, however, is that there are no legal objections to utilizing sub-sidewalk space for utilities, whatever personal objections property owners may have. Also in most places vaults under sidewalks are illegally located, even though tolerated by complaisant officials. On new streets these objections would not obtain to a very great extent. No attempt has been made to consider what may be the best location for all of the sub-surface utilities. They are mentioned because the subject seems to call for their discussion, and when we see the complicated installations of pipes and conduits in some of the streets of our large cities, we are forced to conclude that much of the confusion could have been avoided if early attention had been given to their proper location.

The central location of tracks in streets is considered by all competent authorities to be the best for cities. Such a location is the most logical, convenient and safest for the public. Where possible, on wide thoroughfares, there are good reasons for considering the use of parked spaces for the tracks. Such spaces or areas are safer for all other forms of street traffic and for car passengers. Better car schedules can be maintained due to less interference from vehicular traffic, and parked areas are more quiet, as there are no pavements acting as sounding boards. Also the tracks are cleaner, thus lessening noise due to wheels passing over grit on the rails. The railways can more economically maintain the parked strip and the tendency to neglect such track in times of stress is much less than where pavements must be opened in order to make track repairs. Probably four times as much effective track work can be done in parked areas, as compared with paved areas, for an equal expense.

One of the most frequent sources of trouble with tracks in central locations comes from disturbances of the sub-grade which are due to settlements over cross trenches made for service connections or for additional mains of one kind or another. The railway has had little or no control over such trenches and until the present time it has been difficult to convince municipal highway engineers of the importance of special inspection of all such openings, not only during the work, but also during the restoration of backfill and to prevent undue haste in repaving.

This matter, of course, is not directly concerned with the location of the utilites as a part of the original design, but it is to be considered in respect to the street railway as a located utility, upon which, at present, is placed the burden of care and maintenance, not only of tracks but also of the pavement, wherein this utility distinctly differs from all others occupying our streets. No other utility is obliged to install and maintain pavements for others to use. Any undue influence causing unwarranted expense to the railway in such circumstances should have our attention, and the co-operation of municipal and utility engineers is of vital importance in lessening the trouble incidental to poor track and pavement conditions which are all too frequently caused by outside influences, entirely beyond the control of the railway.

Responsibility for Paving and Its Maintenance

A paper of this character can hardly be considered complete without some discussion of the very important subject of responsibility for paving and maintenance of the same in railway tracks in city streets. What should be the responsibility of the street railway company with respect to the cost of installation and maintenance of pavement? Payment annually of large sums by street railway companies for pavements and their maintenance secures nothing of value to the utilities. The materials which go into pavements are really purchased by the railway company and turned over to the municipality for the benefit of the community at large. The railway company derives no special or peculiar benefit from the construction of the pavement. On the contrary, it is a burden rather than a benefit. This principle has been established by no less an authority than the Court of Errors and Appeals of the State of New York. The duty to pave and maintain the paving of the so-called track area is imposed for the pecuniary benefit of the municipality.

It is not dependent upon conditions that the street railway creates, such as the interference with the surface of the highway due to the presence of the track in the street.

The obligation to pave and maintain the pavement in the tracks is a relic of horse car days. In the old days when all the cars were drawn by mules or horses, the paving charge or tax levied on the street railway was admittedly a fair and equitable assessment. Undoubtedly the horses pounding on the narrow strip between the rails, day in and day out, all the year round, did wear the pavement and the street car operator of those days probably acknowledged the responsibility readily enough, but those days have long since passed. With modern track construction and electrically operated cars, the damage done to the pavement from the operation of cars is relatively small, and in any event, is limited to the pavement immediately adjoining the rails. This fact has been recognized in the State of Connecticut, where the paving burden has been materially reduced by limiting the responsibility of the railway companies to a width of 8 ins. on either side of the rail. Street car loads are carried down to a substantial bearing area over the sub-soil through the rails, ties and ballast, and not through the pavement. With modern rail joints the pounding of the cars over loose joints has been practically eliminated. What then is the principal cause of paving damage?

I was very much interested in reading the editorial review in the Engineering News-Record of May 10, 1923, on the subject of damage to pavement by automobile trucks. A survey of 20 large cities throughout the United States showed that trucks weighing, with their loads, from 15 to 25 tons are not uncommon, and such loads, operating over paving at relatively high speeds, are the cause of most of the cases of pavement failures, sometimes even breaking through the concrete paving foundation. A truck load of even 20 tons distributed over four wheels gives a wheel concentration heavier than will be found on almost any ordinary 8-wheel trolley car. Tests of impact stresses conducted recently by a committee of the American Society of Civil Engineers show that these are actually much higher than for electric railway cars. The conclusion reached in the Engineering News-Record survey was that the pavements generally as constructed in the last ten years will break down comparatively rapidly under the extreme truck loads of 15 to 25 tons which now prevail to some extent in most large cities. I personally know that we have such loads in New Jersey, for I have had occasion to check total weights of trucks operating over our ferry between Edgewater and New York City, and have found weights on four-wheels as high as 23 tons.

Paving Costs Considered as Tax

It is a notorious fact that the electric railways are the most heavily taxed industry. Statistics show that if you add up all the taxes, state and local, for the steam railroads in the State of New York, these companies pay about 27.3 per cent of their net profits in regular taxes. The electric railways, 44.4 per cent, telephone and telegraph, 16.2 per cent, and gas and electric, 23 per cent. Referring to Virginia, for instance, in 1921 the electric railways paid in taxes 36.6 per cent of their total net revenue, an increase of over 100 per cent since 1917 when they paid 13.61 per cent, and these figures do not include any federal taxes. Our American Electric Railway Engineering Association statistics show that, taking the country at large, about 6.5 per cent of all our gross operating revenue goes into taxes and about 3.5 per cent into paving and similar charges, a total of about 10 per cent of the gross operating revenue for taxes. This represents approximately one-half cent of the fare paid per passenger. And this fact must be remembered, the rider pays the paving bill, whether it is in the form of increased fare or increased municipal taxes.

Increase in Paving Burden Since the Beginning of Electrification of Street Car Lines

Comparable figures on the mileage of electric railways then and now show that in 1890, when the electrification of lines was just getting under way, there were about 8,123 miles of single track operated by street railway companies. In 1917, according to the United States Census, there were 44,835 miles. Although the only justifiable basis for the imposition of the paving impost disappeared with the horse cars, the companies today pave and maintain a right-of-way more than five times as long merely because, when the change was made from the horse-drawn vehicles to electrical propulsion, no consideration was given to changed conditions as far as the resultant wear on pavement was con-

cerned. As the street railway companies extended their lines the paving burden became proportionately heavier, for of course the outlying lines did not pay as well as those of the thickly populated towns, while the cost of paving increased more or less uniformly throughout the system. Nor is this the whole story. The type of pavement used at the time these paving taxes were imposed was usually nothing more than a rough gravel, cobble stone or macadam paving, comparatively inexpensive types as compared with those required to meet the demands of modern heavy vehicular traffic. Thus the process of piling up the burden on the street railway company is still going on. A conservative estimate of the total amount expended each year for paving by street railway companies is about $22,000,000, of which about $15,000,000 is for construction and about $7,000,000 for maintenance. This is slightly less than 25 per cent of the estimated total net income of the industry in 1921. In other words, if the industry could be relieved of these obsolete imposts it would mean an increase of approximately 25 per cent in their net income, and would also mean a healthier condition of the traction systems, and greater ability to maintain their lines in condition to meet increased demands upon them.

Street railway fares are not readily susceptible to changes from time to time. Only under the stress of extraordinary circumstances are increases in fares granted. Periodical variations in the rate of fare merely to cover taxation would not be tolerated by the public. If the private merchant finds that the selling price of his various wares is not sufficient to meet the needs of his business there is nothing to prevent his increasing the sale price to meet the requirements, but this is not so easy with a utility like a street railway company. With the merchant an increase of a cent on each article sold may produce the necessary additional revenue, and this is usually a small percentage of the total cost of the article, but in the case of a car ride an additional one cent, which is the smallest unit of our monetary system, added to the rate of fare means anywhere from 10 to 20 per cent increase.

Relief From Paving Obligations

The question of relief from the paving burden is a vital one to the street railway industry. Relief has been granted in a certain relatively small number of cases through special legislation. A good beginning has been made and the sentiment for complete relief is gaining ground among thoughtful people. It would appear to be high time that laws making burdensome paving requirements on the street railway companies should be repealed and the justice of the street railway's claim for relief from the responsibility for paving expense recognized, and this burden placed where it properly belongs.

The foregoing matter is from a paper presented by Mr. George before the State Engineers' Section of the Conference of Mayors and Other City Officials held at Buffalo, N. Y., June 13, 1923.

SOME VICISSITUDES OF A MUNICIPAL ENGINEER

By John F. Druar, of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn.

The ordinary university course in engineering is too narrow in its teachings and there is not enough elective work to open a student's eyes to the world. One goes in, takes a prescribed course and passes out to some job. Perhaps he likes it and perhaps he does not. At any rate, he is seldom up to filling the job the way it should be filled. I know I was not up to my first job and remember I once tried to get a contractor to shoot out a retaining wall and replace it because a blast had loosened the forms and allowed the wall to bulge here and there, perhaps an inch and a half in the worst places. After a talk with the contractor, who really treated me like a patient father, I no longer insisted and started to fill my job as I should fill it, learning to insist where it was essential to use my judgment in all cases and finally knew my job. Long hours and little pay was the cub engineer's lot in those days and one worked and carried the "Message to Garcia" or just quit ignominiously. I had a hard time arriving but was fortunate in working on some of the largest pieces of work in the country at that time and of having responsibility thrust upon me. I remember one occasion, being called in from an important piece of work, handed an old-fashioned 45 Colt revolver with a box of cartridges and told I was now foreman of a boiler shop, the crew of which had struck. They handed me a gang, or rather a mob, of foreigners and I was told to run the shop. I did not know over-much of the operation of a

boiler shop, but ran it for six weeks and could not hear normally for a year afterwards.

Trouble With Employes

Long ago we found that a municipal engineer, to be successful, must devote a great deal of his personal time to the exact planning of the work and to improvements in plan and method of carrying on the work, to the sale of his services, and reduction of costs wherever possible. We have in the past found a considerable amount of trouble with employes hired on trial who do not always carry their "Messages to Garcia." While we have tried to select the best, there has been a large, in fact too large, turnover of employes'. Many did not satisfy. They did so much and no more. They did not have the proper perspective and did not think for themselves the way they should. This is problem number one and perhaps as great as any. If I had in the past been sent two or three hundred miles to get certain information and failed to get all the information necessary for the layout of the work in question and if I could not have answered all the questions put to me I should have had a "can" attached without delay, yet in taking on men I have found too many who failed in this particular manner. The usual excuse was, "You did not tell me you wanted that." Now this failure has been so universal that there must be some fault with the college training of these men. (Where I received $1.25 per day, when I started in after my course of mechanical engineering, we now have to pay a cub $125 per month and expenses out of town). Much could be forgiven a man if he did the work after a year's apprenticeship and did not require some one to do his thinking for him, but, alas, too many do no thinking, they don't plan the direction of the work in the right way, they keep careless notes, they do not familiarize themselves with the specifications which give the contractors and engineer specific duties to perform. They use poor judgment and have not been trained to think. To be sure, we have eliminated the poor ones from our rolls in the past, but it has been a problem.

Selling Engineering Service

The next problem is that of selling our services. First, municipal work has its ups and downs, a good year and several bad ones. Suppose we visit a town once and the council decides to proceed with some work, and they sign a contract. We proceed with the work and in a year's time the work is completed, and is entirely satisfactory. Do they employ us for the next piece of work without question? No, the council may have changed, some other engineer may have come in at the psychological moment and without even asking us for an opinion or a proposition for engineering, they select some one who may be a good talker, but who combines good talking with a cut in rates and a discourse on how our fee for the work was too high. There are engineers who will cut rates to a point where there is no profit, for the sake of getting the work. How they live, we know not. We do know, however, that they cannot afford to give such service as would be a credit to the profession. (We know that the cost of the complete work often rises far above our costs for the same work, but as the work is done but once there is no chance to prove this except on comparison of the assessments or bond issues that are spread for work of the same nature).

Often we find several engineers of more or less ability, several salesmen of engineering, who go out with the avowed intention of landing the job at any percentage they can get, and often short-sighted councils will select the cheapest man. I remember one case where an engineer took a piece of work for a little fee of $100, one other set a price of $750, and several others asked prices between $1,000 and $2,000, while we and some other engineers asked 5 per cent of the cost for engineering service, which would have amounted to $3,000. The council selected the $100 man! No wonder there is an increased demand for City Managers.

Lack of Progressive Spirit

Very often we find a council recognizes the fact that sewers, water or pavement should be installed, that they personally want them, but that the citizens do not, or perhaps the banker does not, want them. It is not the proper time, prices are not right, etc. It sometimes requires a lot of patience and forebearance not to tell them what you think of non-progressiveness in this day and age. I have talked to councils about making a report with blueprints showing the people where the mains will be laid, the cost to the property owner and other points. I have shown where the cost of water spread over a period of ten years amounts to less than 3 cts. per day for a 50 ft. lot.

I have shown that the insurance (guaranteed reduction) would pay for the improvement—all to no avail. The work was put off—Why? Just because there was not one man on the council who had the initiative to make a motion that would start his town toward progress. Then I have had them make a negative motion. Of course it is not necessary to make any motion if they do not want to do anything. I explain this and several times I have asked a councilman to change his motion to a positive one, whereupon the motion carried and the work went in. I have never found a town that put in any improvements who would have returned to the old conditions. I do not like to go out and have to sell service, trying to convince a town that they must have improvements for it is a thankless task. Often it seems undignified.

Some Attractive Features

Municipal work has its attractions, however. I like the personal contact, the clash of minds and the overcoming of prejudice against improvements. I know we are helping to build communities through our efforts and that after we leave a piece of work we have accomplished something which is worth while and that we have given the people something for their money. A municipal engineer has a great deal of responsibility in his profession and if successful his influence is felt wherever he does work, for he provides the improvements which stand for the upbuilding of the community and indirectly he influences the character of the people in every town in which he does work. First, with a water system, he helps in an economic way to fight the demon fire. He gives the people the opportunity to have a pure, wholesome supply of water unlimited in quantity which, when utilized in the homes, streets and gardens gives a cleaner and healthier town. The people at once begin to take a greater pride in their surroundings and the tone of the whole town improves.

Again, it may be an electric light plant with cheap universal power which helps to build the payrolls of a town. The small town to be a success must have a live Commercial Club ever on the alert to annex some industry, creamery, mill or canning plant so that the community may have an income independent of the money spent by the farmer for clothes and supplies.

Again, with a sewer system, the disposal of wastes and cellar drainage is solved for all time. No more privies or cesspools in the back yard with the fly breeding that takes place in such surroundings. No more are the slops from the kitchen sink thrown on the door sill. Again the people are lifted out of the mire by pavements. Who but the engineer is to tell the people that in the past for makeshift roads they have spent more than they would for a permanent pavement?

Competitive Bidding of Engineers

Thus it goes, but the engineer cannot expect business in these days to roll into his office. The municipal engineer must be constantly on the go or starve. Municipalities instead of selecting an engineer on merit, in some instances advertise for engineers and have a competitive letting, selecting the cheapest engineer of the lot, regardless of the lack of experience, familiarity with the work or other requirements. The result is always poor municipal work and a black eye for the profession, unless the mistakes and high cost are not discovered because there is no chance of comparison.

The City Manager

We now have among us the City Manager who comes with the best of intentions to run the business of the municipality, not knowing quite the expectations of the Mayor, and to make himself a good fellow he decides he can do his own engineering in addition to his administrative duties that should take all his time. This does not redound to the credit of the City Manager who, if he would, could well insist on the employment of a first class consulting municipal engineer to direct the whole improvement and to furnish estimates and draw plans for the work. It is to be hoped that the City Manager may see the light in this respect and stick to his calling. We like the idea of a City Manager and if we do not have to fight him for work, which is the province of a municipal engineer, we will gladly boost for him and recommend that a Manager be employed as a Manager is what most towns need.

Worrying Through

The city or village councilmen are seldom paid enough for their services to make it an object to run for the office or to properly handle the office after being elected. They may be public spirited and have a burst of righteousness for a few meetings, then they drop into a rut and try to worry through their term, trying

not to antagonize the citizens by even suggesting any improvements. They feel that if they talk for improvements, the citizens will not patronize their places of business. No one wants to take the bull by the horns and come out for a needed improvement. I have attended meetings of citizens and councils where a citizen would get up and finally cause the council to take action, for the citizen would see the light. "If improvements are made, we will be taxed," seems to be the gist of the cry of all. The people fail to see that a tax on property for sewers or water or pavement simply reduces some cost they are standing somewhere else and to convince them of this becomes the duty of the engineer.

DISCUSSION OF CONTRACT VS. DAY LABOR SYSTEM IN THE CONSTRUCTION INDUSTRY

By Charles A. Mullen, Consulting Paving Engineer, Milton Hersey Co., Ltd., Montreal, Quebec.

(Editor's Note: This magazine favors the contract method of conducting construction operations in the field of public improvements, for reasons often stated. However, there are many who hold to the opposite view, that the day labor system is preferable, and discussion of this familiar subject from time to time is desirable. The present article, an enthusiastic statement of the advantages of day labor as they appear to the author, is from a paper presented at the Public Ownership Conference held at Toronto, Ont., Sept. 10-13, 1923, under the auspices of the Public Ownership League of America, Ontario Hydro-Electric Power Commission and the City of Toronto.)

Maj. F. S. Besson, Assistant Engineer Commissioner of the District of Columbia, has recently published a book entitled "City Pavements," which supplies me with exactly the figures I want for the purposes of illustration; but Washington might just as well be New York, or Toronto, or Buffalo, or Montreal, or Charlottetown, Prince Edward Island, as far as the general facts are concerned It would only be necessary to apply the local cost figures for labor and materials, and the rest would be about the same.

In Major Besson's estimate, after figuring the costs for materials, labor, supervision and overhead; in fact, all the knowable costs, he adds 10 per cent for contingencies and then 15 per cent for contractor's profit. Not contractor's wages, mind you, but profit; for, if the contractor has actually worked as a superintendent or manager or even president of his own corporation, he has usually not overlooked paying himself generous wages or salary for his actual sweating at the brow, and charging it in as overhead, before figuring his 15 per cent profit. That is what good business men like you and I would do were we in his place.

Between buyer and seller, fraud sticketh as mortar between bricks; at least, so says the Bible. Now for the moment, let us assume that the Bible is wrong in this statement, and that both the contractor and the city officials are strictly honest, which I believe is often the case. Then the difference between the public and the private ownership of the street paving industry of the city of Washington is the contractor's 15 per cent profit plus a large part of the 10 per cent contingency item and a very considerable part of the overhead, say at least 20 per cent in all.

Not unwisely did I select the case of the city of Washington, for few there are who will be so bold as to state that the Engineering Corps of the United States Army, which built the Panama Canal under General Goethal's public ownership after private ownership of the canal building industry at that point had failed, and to which army engineering organization Major Besson belongs, is capable of efficiently organizing and operating a publicly owned street paving industry for the city of Washington; or for the United States of North America for that matter.

Men will not work as well under public ownership of an industry as under private ownership, is an argument frequently advanced. My own experience has been to the contrary. I have been able to get the same quantity of work and of better quality from men through publicly owned industry than through private, both at times when I was in charge as a city official and more recently when, as consulting engineer, I have assisted in directing the execution of street paving programs.

High prices for materials will be paid by the publicly owned industry, is another argument frequently advanced. From my own experience I know that a public body can purchase as cheaply or more cheaply. Of course monopoly com-

binations are sometimes made against the public. Montreal was recently face to face with what seemed to be a monopoly in sand. The Administrative Commission very quickly purchased a sand pit, and today monopoly in the supply of that material is broken definitely by the public ownership of a unit of the industry sufficient to supply the City's needs.

Public ownership can, if it will employ the best managers and workmen, purchase the most suitable plant and materials, and proceed with the work precisely as does the contractor, or better; and in doing so, it eliminates not only 15 per cent profit, but the contractor's overhead cost of competition, private financing, bonding, and much of the risk. Moreover, a publicly owned industry, being based on the solid foundation of service, and having a monopoly that is both legal and just, can safely make a larger investment in plant and machinery and in the continuous services of competent men.

But public ownership will not, says a very intelligent Montreal contractor, who does not agree with me on this point, and he recites many of the ills of publicly owned industry—patronage, indolence, lack of interest on the part of some of those in charge, and so on. Well, we who constitute the public have got to see that public ownership will and that it does; if we do not, it is our own fault. Public ownership did in the case of the Panama Canal, and when we are ready for it, it will do so in other lines of work, such as the building and maintaining of roads and streets.

But once we award a contract, the contractor is entitled to every courtesy and assistance from public officials. I have never had any sympathy with the contractor-baiting engineer, who draws an agreement which he himself could not live up to were he undertaking the work directly by day labor, and then proceeds to make the life of the contractor miserable. In such instances, in fact, I have a considerable sympathy for the contractor, who, being quite human, proceeds to "do" the engineer. I have in mind such an engineer under whom I worked as a contractor, and my one regret is that the public pays the piper.

When waste and inefficiency are the order of the day under the public ownership of an industry, the political conditions are usually such that private ownership of the same industry would be both corrupt and wasteful. Under public ownership, the electorate has some chance to correct the bad management, the post office for instance, while under private ownership of the coal mines we seem to have a very hard time making corrections. Moreover, a privately owned industry that is mismanaged is usually found financing the fight to maintain the status quo with part of its ill-gotten gains.

Private ownership of industry is always wasteful from the public's point of view. There is much wasteful duplication of plant, management and financing, and where a publicly owned paving industry could afford to install very modern equipment and management, because of its monopoly, the same paving industry, owned as several units by competing contractors, each controlling only a small fraction of the work and having but a doubtful control of that, cannot afford the same general efficiency, though each unit may be quite efficient when considered separately as such.

A manager may be selected under public ownership of the road making industry; while, under private ownership of this industry, the public governing body usually has to accept whoever blows in with the lowest financially responsible bid. When a road making contract is awarded today, it is seldom an arrangement between persons, it is rather an arrangement between a public body and a bunch of money sufficient to finance the contract, and here arises an interesting point.

The cost of financing work is generally duplicated under the contract system. The contractor, in bidding, must estimate his cost of financing the job. Usually, the public funds are in the bank waiting to pay him as soon as the job is completed. The bank is paying the city anywhere from zero to three per cent interest on the money, and the contractor is borrowing the equivalent of the city money from some bank at 6 per cent plus to pay for labor and material. Under public ownership, the money is immediately paid for the labor and material, and the cost of private financing, often a very expensive item to a firm not financially strong, is entirely eliminated.

Another item of waste under the contract system of doing street paving work came to my notice very forcefully last year; the non-efficient use of the avail-

able equipment due to divided managements. It happened that, in the same month, one contractor with a plant in the north end of the city of Montreal hauled material about ten miles across town to lay it almost at the other's doorstep, while the second contractor hauled identical material from the west of the city to the north. Ninety per cent of this hauling was waste.

No contract and specifications, in the way they are known to the contract system, are necessary in a privately owned industry. This does not mean that plans and requirements are not necessary; but what is needed is drawings with sufficiently clear explanations or descriptions. A city engineer in this very province not long ago told me the cost to him of building cement sidewalks and curbs by day labor. It seemed rather low, and I asked him for the specifications. He told me that he had none, and did not need them; but he showed me his drawings and sketches with explanatory statements on them. His reply was: "We have the accounts of material and labor, and, as far as the dimensions are concerned, you can go out and measure the job." This man's work is notoriously good, so I did not bother making further investigations.

There will be no law suit between the city and the contractor on this work—because there is no contractor, and it takes two to make a quarrel. Neither will there be any extravagant claims for extras. The publicly owned industry builds for use, not for profit; while the contract industry builds for profit first, that is its motivating power. Public ownership accounts are usually open for all to see—that is as it should be; but private industry is usually very jealous of its records.

I usually have to explain that I am not an unfriendly critic to contractors; what I do criticise is the contract system as such. Contractors are men just like us, not much different; and, as long as we indulge our indolence to the extent of employing the contract system in our industry, the contractor is entitled to his 10 or 15 per cent profit, or whatever legitimate competition will give him. It is our fault if we pay this extra amount in order to get our work done in this manner.

The contract system lends itself to much abuse. So far, we have been discussing the contractor who is rated as an honest man, as honest as we are; but, unfortunately, the business lends itself to some very shady transactions. We have our patented pavement monopolies, and our material monopolies, and we sometimes have arrangements among contractors by which they eliminate the competitive element and arrange their prices to suit themselves. Moreover, the politico-contracting ring is ever with us, and the concessions in exchange for contributions are only too well known.

One government chases the other out of office by pointing to its questionable practices in connection with road contract work; only, as a rule, to substitute equally questionable practices of its own. The criticism of the last Ontario governments' road practices had much to do with its defeat; and what old state of the Union has not had its investigations and upheavals from the same causes?

Public ownership does not bribe public bodies. Did you ever hear of a municipal electric light plant or any other municipal industry trying to bribe the city council or offering any party a campaign fund? A small contribution from the individuals of such an industry levied by the party in power is about the limit. Have you ever heard of the bribery and corruption in connection with street railway franchises or street paving contracts? I do not need to ask the answers to these questions. An incorrect system produces undesirable results, and private ownership of industry has about thoroughly proven itself incorrect. Human nature cannot stand it.

The Hydro-Electric Commission of the Province of Ontario is in a fair way to solving its problem, despite poor old human nature. My own view is that we need many other such commissions, and one of them should be a road and street making commission that would have its organizations centrally located throughout the Province to serve both its own needs for provincial highways, county needs where such are required, and municipal needs as well. There should be an Ontario road making and paving industry, "dirt" contractors eliminated as such and hired as managers where competent ones will accept employment.

As a matter of expediency, public ownership cannot be profitably installed unless the public body or federation of public bodies can command and use the output of an economical unit of the industry involved. A very small town cannot afford to purchase a portable paving plant

to use but once or twice in ten years; though the county in which it is situated might advisedly purchase such a plant and perform the work for its several towns; or, a province might own a number of plants, and operate them for provincial highways and village and city streets as well.

As a matter of necessity, Charlottetown, Prince Edward Island, decided to own its street paving industry. It was so far away from the usual contracting centers for this work that no contractor seemed anxious to go there and pave its streets at a reasonable price. Charlottetown purchased its municipal grading equipment, its municipal concrete mixers and its municipal asphalt plant, secured the few expert men necessary, and proceeded to do the work itself. We have yet to hear of a city, even better situated, which has done better for itself through the contract system than conservative little Charlottetown has done through the public ownership of its own street paving industry.

A matter of good business, the Charlottetown taxpayers and public officials would tell you; as they compare the costs under their publicly owned street paving industry with those under the contract system of surrounding towns and larger cities that may try to look upon them as provincials. It is good business for the public, conducted by a good business administration; not good business for the contractors who might have been adding very much to the cost of this work with no increase in its quality. Should you tell a native of conservative Charlottetown that his city had done anything radical, he would laugh at you.

"Business—Ancient and Modern," is the title of a pamphlet that I recently received from Mr. J. C. Trautwine, Junior, the man who edits the Civil Engineers' Handbook that we all know so well. In this article, Mr. Trautwine points to private ownership as the ancient and to public ownership as the modern method of handling community business; and shows the really rapid acceleration, as viewed by Father Time, of the change from one of the other that to some of us seems so slow when measured in terms of our own day and generation.

In the Province of Ontario the change from the ancient to the modern is going on apace. Behold the Ontario Hydro-Electric. Behold the Toronto Street Railway. Behold Toronto, Hamilton, London, Saint Catherines, Brantford and other Ontario municipalities owning their own paving plants and building and repairing their own streets. What is needed next, it seems to me, is an Ontario Road and Street Building and Maintenance Commission which will co-ordinate the public ownership work already done along this line and rapidly extend it.

To summarize the situation, it may be said that a publicly owned street and road making industry will have at least the following advantages to the public over a privately owned industry:

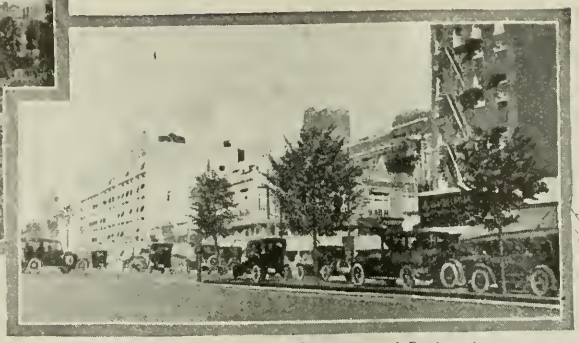
1. Contractor's profit is eliminated.
2. Cost of competition is eliminated.
3. Overlapping of work is eliminated.
4. Duplicate financing is eliminated.
5. Cost of litigation is eliminated.
6. Bribery and corruption are eliminated.
7. The risk or contingency item is reduced.
8. The overhead charges are reduced.
9. More modern equipment is practicable.
10. Suitable managers can be secured.
11. The motivating force is use.
12. The profit is the public's.

As a concluding statement, I shall merely quote the words of Major-General George W. Goethals, after he had completed the Panama Canal by direct labor, without the assistance of the contract system. He said: "I would do it all over again the same way." And one of the contractors who had bid on the work, afterwards declared frankly that it was being done more cheaply and more expeditiously than would have been possible under the contract system. If the publicly owned canal industry could succeed so well, why do we still believe that the contract system of privately owned industry is necessary or advantageous to the public in our road and street making industry?

A STUDY OF TRUCK OPERATING COSTS

Motor truck transportation has had a remarkable development in this country, particularly in the last five years. Twenty years ago there were no motor trucks while today there are more than 1,000,000 registered in the United States. Motor truck routes are being established all over the country varying from one truck to large fleet operations, and both the

Beautiful Riverside Drive, New York City, Tarvia since 1914.



Typical traffic on the Grand Concourse and Boulevard, New York City, Tarvia since 1911.

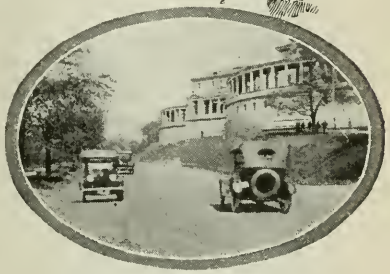
500 Miles of Tarvia Streets in the City of New York

In New York City, street construction and street maintenance are problems of tremendous difficulty. For New York's Bureau of Highways has to cope with the ceaseless, grinding traffic of more than 400,000 automobiles and 60,000 horse-drawn vehicles.

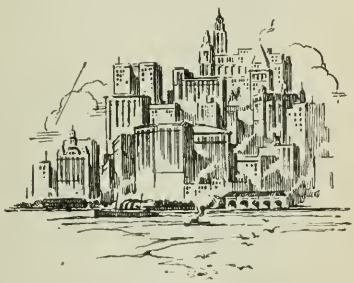
And Tarvia has played its part in solving these problems. First used in 1906—today there are more than 500 miles of Tarvia streets in Greater New York.

But, not only in New York, in thousands of other cities and towns, Tarvia is solving the good roads problem. For Tarvia roads are firm and smooth, mudless and dustless at every season of the year. Furthermore, they are far less costly to build and maintain than any other type of modern highway. Tarvia insures the most miles of good roads that can possibly be built and maintained with the road funds available.

Experience has proved that this country needs greater mileage of moderate-priced, low-maintenance all-year highways. Tarvia roads meet this need. There is a grade of Tarvia for construction, repairs and maintenance.



Hall of Fame, N. Y. University, on Sedgwick Ave., Tarvia since 1918.



If you will write to our nearest office we will promptly and gladly give you practical co-operation in solving your road problems.

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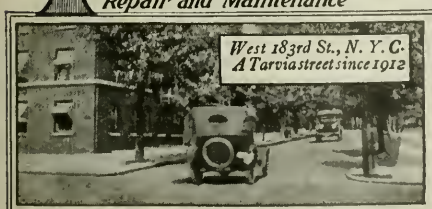


West 183rd St., N. Y. C. A Tarvia street since 1912

75th St., New York City. A Tarvia street since 1912

passenger and freight traffic is increasing very rapidly.

As millions of dollars are invested in the truck transportation business and the organization of this business is quite well systematized, it would naturally be expected that very complete and accurate data covering costs of various types of truck transportation would be available. On the contrary very little dependable data of this kind is to be found. Many truck operators are keeping "so-called costs" but a careful investigation of their cost systems reveals the fact that they are overlooking such important items as "overhead," "interest," "depreciation," "garage rental" and other items that must be included in any accurate cost system. Consequently many of the low cost bubbles can be punctured easily by a careful investigation of the system used in arriving at the operating costs.

There are many truck users who maintain very complete cost systems on every other branch of their business except their trucking. Many fleet operators determine their truck operating costs simply by subtracting the yearly expenses from the yearly receipts of the business. On such a system apparent profits frequently cover business conducted at actual loss.

At the suggestion of Dean A. A. Potter, of the Schools of Engineering, of Purdue University, Ben H. Petty, Assistant Professor of Highway Engineering, in November, 1921 undertook a survey of truck operating costs in Indiana, and the investigation has been carried on intermittently since that time. Bulletin No. 10 of the Purdue Engineering Experiment Station, Lafayette, Ind., issued by Prof. Petty in February, 1923, is a report on the results secured in the investigation to that date, and also includes a simple presentation as to how and why a truck operator should record operating cost data. The survey is being continued and additional data will be published when available. Effort will be made to secure comparative cost data on all sizes of trucks in various classes of service over different types of roads.

Professor Petty's introductory remarks are here reproduced:

"Motor truck transportation is a business that is becoming firmly established in spite of the many failures experienced in the past. The economy of the motor truck in handling short haul freight shipments has been clearly demonstrated in numerous cases. Several railroad companies in the New England States, for example, have installed their own motor truck lines to handle all freight shipments under the 50 mile limit. The establishment of new trucking lines and the extension of their radius of operations depends to a great extent on the extension of hard surfaced roads from city to city.

"In considering this extension of motor truck activities it must be borne in mind that, like any other form of transportation, it has distinct fields of economic usefulness. Whether the operator entering one of these fields will prove successful depends largely on how carefully he analyzes his business through the medium of adequate, accurate and complete cost records.

"During this rapid development of motor truck transportation, there have been numerous failures, ranging from the one truck operator to the large fleet owner. It is probably safe to say that at least nine-tenths of these failures were due primarily to a lack of knowledge of the actual cost of operating the trucks, rates having been established in a haphazard way based principally on guess work. Scores of trucks have been returned to the dealers during the past two years by disillusioned operators who bought them on the installment plan expecting to pile up a large bank balance in a few short months. Many of these men figured their operating costs as including only gasoline, oil, tires, repairs, etc., and neglected such items as depreciation, interest on investment, and even their own wages as driver.

"On the other hand there are numerous truck operators making fair returns from their investment due principally to accurate cost accounting. Many operators are clearing from one to three thousand dollars a year on a single truck."

AUGUST PAVING BRICK SHIPMENTS HIGHEST

Paving brick shipments for the month of August were higher than for any previous month in 1923, according to statistics issued by the National Paving Brick Manufacturers' Association. Reports from 67 per cent of the industry's tonnage showed that shipments were more than nine million greater for August than for July, 36,446,000 being shipped in August and 27,092,000 in July.

EDITORIAL

A BALANCED NATIONAL SYSTEM OF TRANSPORTATION

For some time past the Chamber of Commerce of the United States has been showing keen interest in a proper co-ordination of highway, railway and waterway transportation facilities. A natural result of this study is a plan for linking organized motor transport with railroads in the development of a balanced national system of transportation. The plan is outlined in the report of the committee on the relation of highways and motor transport to other transportation agencies recently submitted to the president of the Chamber.

Important changes in prevailing methods of handling and distributing freight are proposed. Store-door collection and delivery to relieve congestion within crowded terminal areas of large cities; the use of organized and responsible motor transport to relieve railroads of various forms of uneconomical service, including the unprofitable short haul; the wider use of self-propelled railway cars, and the extension of passenger bus service to supplement existing facilities are recommended.

In connection with these changes the committee suggests the regulation of common carrier operations of motor vehicles by federal and state commissions which have supervision of rail and water carriers, and systematic development of highways in response to general traffic needs.

Those who have studied these questions, particularly the state regulation of motor transport, will be interested to know that the chairman of the committee is Mr. Alfred H. Swayne, vice-president of the General Motors Corporation. This committee is one of five appointed by the national chamber to study different phases of the transportation problem and to lay the groundwork for a national policy to be discussed at a general transportation conference to be announced later. It is said that the recommendations represent the unanimous view of all the important interests directly concerned in or affected by transportation. Its personnel includes railway traffic officials, officers of farm and labor organizations, representatives of the motor industry and motor haulage companies, water carriers and the shipping public.

The more important conclusions of the committee may be here briefly summarized as follows: Co-operation between the various agencies of transportation is preferable to wasteful competition. The greatest opportunity for co-operation is in the terminal areas of large cities. Store-door delivery by motor truck to relieve terminal congestion is the most promising method of solving the terminal problem. Organized motor transport can also relieve the railroads of various forms of uneconomical service, such as trapcar service, switching between local stations and short-haul shipments within the terminal area. More use should be made of demountable bodies, trailers and semi-trailers, containers and container cars, and mechanical handling appliances. Outside terminal areas there are distance zones, of varying extent, in which the motor is preferable for short hauls and the railway, or waterway, for long hauls. In intermediate zones competition is inevitable. Motor trucks and buses should be used to supplement the facilities of existing common carriers. The railroads should be permitted to discontinue unprofitable service to which the motor is better suited, and the motor should abandon its efforts to handle general traffic over excessive distances. Sound financal organization of motor transport is necessary, as well as public regulation of common carrier motor service. Passenger bus transport should be so regulated as to secure the best service to the public, certificates of public conveniences and necessity as already required in many states being a useful means of insuring reliable and continuous service. Rail lines can often advantageously extend or supplement their services by bus lines, and in states where this is now prohibited such restrictions should be abolished. Regulation of traffic and of size, weight and speed of motor vehicles by states and municipalities having control should be made more uniform within states and as between states. Regulation of common carrier operations of motor vehicles, including rate regula-

tion, should be handled by the federal or state authorities, under the comissions which now control the operations of rail and water carriers. Trunk highways in any area should be able to carry the normal vehicular traffic of that area, and, if the traffic economically justifies the use of especially heavy trucks, highways with stronger sub-bases must be provided. In general, present types of highways, present routes connecting principal centers of population and production, and the present trend in size, weight and speed restrictions of vehicles using highways show a rational system of highway development that should be continued. Investigations under way to determine the economic role of the motor vehicle should be continued.

The program of transportation co-ordination of the Chamber of Commerce of the United States, as above reviewed, is highly commendable in its purpose and scope, and generally well considered in its recommendations, but the editor of this magazine wishes to call attention to one phase of this question deserving close study and the eternal vigilance which is said to be the price of safety, in this case the price of safety for the development of highways and highway transport. Anyone who supposes that the railway managers of this country are ready to embrace motor transport is still somewhat ahead of the progress of events. Some are, of course; in fact some rail lines are utilizing motor transport, but others are fighting it.

The one positively dangerous proposal made by the committee of the Chamber of Commerce is that state public service commissions be given the absolute power of life or death over motor transport enterprises. Our words are not the words of the report but they mean the same thing for when a state regulatory body has the right to grant or withhold certificates of public convenience and necessity and to fix rates, schedules, etc., it has absolute power. Those who are ready to assume that such regulation will always be fair to motor transport are at liberty to do so. For our part the proposal fills us with forebodings and misgivings. In the first place motor transport is still in such a highly experimental stage of development that no one knows just how to regulate it, even with the purest of motives. It needs more time to develop by trial and error before fair regulation may be attempted with promise of success. Again, there has been much complaint about state regulation with only two parties involved; the public and one utlity. Think of adding a third party to this mix-up! The prospect gives us pause. What show will a small motor transport operator have when he must go before a commission and face the destructive criticism of the brilliant lawyers the rail lines are able to employ?

Not long ago the Illinois Commerce Commission denied a certificate of public convenience and necessity to a truck company operating a fleet of 40 trucks on regular published schedules in competition with three steam roads and an interurban line between Chicago and Joliet. The Commission ordered the trucking company, as well as several other companies uncovered in its investigation, to discontinue business. The Kipps Express and Van Company, which had petitioned for the certificate, was shown by the evidence to advertise and operate a regular daily service to 40 towns with published rates on connecting services between Chicago and five other towns from 20 to 50 miles distant. Regular warehouses and rate zones were also maintained. Some of these services were shown to have extended over a period of three years. The Commission stated that its policy is not to issue such certificates unless it can be shown that there is not adequate service and that the proposed carrier has the capacity to handle all the traffic, if need be.

The discerning reader will have no difficulty in perceiving the difference between the idealistic state visualized by the committee of the Chamber of Commerce of the United States and the state of affairs actually existing. The Chicago-Joliet district as an "outer-belt" district; just such a district as the committee must have had in mind when it spoke of "intermediate zones in which competition is inevitable." "Inevitable" under the free play of economic forces, but not under the ruling of the Illinois Commerce Commission. This Kipps case is most instructive and we hope will be impressive to all those who are ready and willing to tie up the future of motor transport and hand it over to the care and keeping of state public service commissions. In many ways we greatly admire the railways. Their achievements in many fields of endeavor are unequaled. For example, they have produced the greatest outdoor sign ingenuity has ever devised. It reads: "Stop, look and listen." We commend the message of this sign to those who favor state regulation of motor transport at this time.

MISSOURI'S ROAD PROBLEM

By B. H. Piepmeier, Chief Engineer, Missouri State Highway Commission, Jefferson City, Mo.

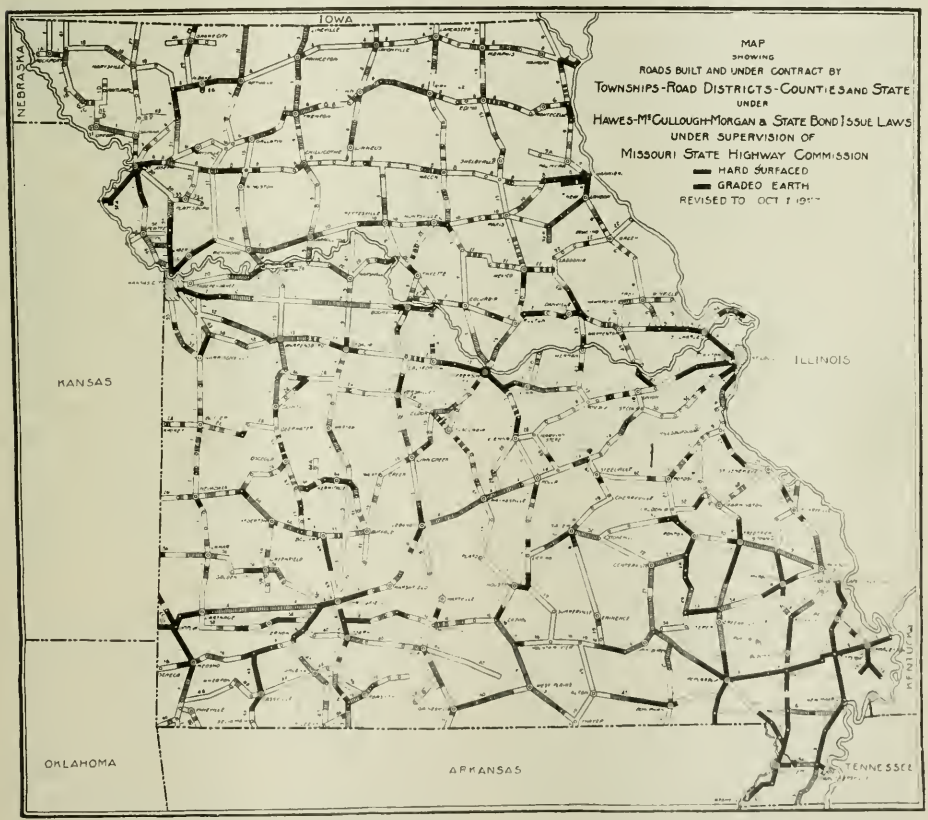
In its entirety, Missouri's road program embraces the construction and maintenance of approximately 7,640 miles of hard surfaced state highways. These highways, forming a connected system, were designated by the State Legislature at a special session in 1921. This system includes the main traveled roads connecting the county seats and all the important centers of population and comprises nearly 7 per cent of the total road mileage in Missouri.

Provision was made in the law creating the system for the selection, by the Highway Commission, of certain preferred routes for improvement with higher type surfaces, in order thereby to serve economically the heavier and denser traffic. In its selection of these higher type, or primary roads, the commission was authorized to deviate from statutory designations in the interest of economy and directness of route between important centers of population.

The remaining part of the highway system, known as secondary roads, is defined by the statute, and little or no option is given the commission to vary from this statutory designation. The completion of this entire program is a very large undertaking.

At present the Highway Department is directly concerned with the expenditure, insofar as it may go, of a $60,000,000 bond issue, assisted by some undetermined amount of federal aid, toward the completion of the state highway system. Some of the work previously done by the Highway Department in earlier years will be available as parts of this more recent designated state system. This earlier work was carried on by funds raised by the counties, the state, and a goodly portion of federal aid.

To give the road program an impetus and the Highway Department a more



MAP SHOWING COMPLETED MISSOURI STATE HIGHWAY PROJECTS AND THOSE UNDER CONTRACT AS OF OCT. 1, 1923

Solid Lines Show Hard Surfaced and Shaded Lines Graded Earth Roads

direct initiative and control of the state highway system, a bond issue of $60,000,000 was authorized by an amendment to the constitution carried by a vote of the people. Provision was made to pay the interest and sinking fund charges out of the annual fees collected for automobile licenses. These bonds were to be issued annually in amounts not exceeding the statutory limitations until the entire $60,000,000 had been sold.

The first issue was that of Sept. 1, 1922, for $5,000,000. The second issue was that of Dec. 1, 1922, also for $5,000,000. The next issue occurred Nov. 1, 1923, for a similar amount. As provided by law, the proceeds from these bond sales are divided between the primary and secondary roads, so that the primary system secures one-third plus $6,000 per mile of primary roads. The remaining portion of the bond issue money is allotted to the secondary roads. Federal aid funds available are apportioned one-third to primary and two-thirds to secondary. On this basis there will be available for the 1,540 mile primary system, out of the entire bond issue, $29,240,000, or an average of about $20,000 per mile. For the secondary system, covering 6,100 miles, there will be available from the entire bond issue, $30,760,000. The residual amount of federal aid allotments available for the state highway system was, at the time of issuing our first bonds, $6,441,488. This allotment will hold good until June 30, 1925, after which date the amount of federal aid available is a matter of conjecture, for Congress has not yet made appropriations beyond that date. The state secondary system has been estimated to cost $108,689,000. From this is readily seen that the present program will fall short of completing the entire system.

Moreover, the law provides that work shall be done simultaneously in the 114 counties of the state, and that each county shall receive its proportionate part of the mileage allotted it. It is obvious that a number of detached, disconnected road projects, even though completed, will not serve state-wide traffic. This may be overcome to a degree by the concentration of effort and money on a few of the primary roads connecting the most important population centers and thereby furnishing a measure of service to the state-wide traffic.

The accompanying map shows the location of our state roads, the projects that have been completed, and that are now under contract. Distinction is made, by means of shading, between the hard surfaced roads and the graded earth. It has been the policy of the commission to do a large amount of grading, so that the embankments would have time to settle, and the entire road be packed by the traffic before it is surfaced.

STATUS OF MISSOURI STATE ROAD PROGRAM OCT. 1, 1923

	Miles	Value
Total Commitments	3,022.099	$41,771,134.65
Projects completed	1,256.640	13,860,831.32
Proj. now under cont.	1,765.459	$27,910,303.33
Detail of Projects Completed—		
Graded earth	651	4,875,971.60
Hard surfaced	606	8,984,859.72
	1,257	$13,860,831.32
Detail of Projects Under Contract—		
Graded earth	944	$ 8,528,581.15
Hard surfaced	821	15,884,835.36
	1,765	24,413,416.51
Bridges		3,496,886.82
		$27,910,303.33
Detail of Road Mileage Completed—		
Graded earth	1,094	$ 5,686,000.00
Hard surfaced	918	16,017,100.00
	2,012	$21,705,900.00

Total mileage in state highway systems, 7,640 miles.

From the accompanying statistical table, it is seen that our entire commitments, to date, approach $42,000,000. Of these commitments nearly $13,000,000 worth are covered by bond issue funds.

In addition to the construction program, the department has inaugurated, during the past year, a maintenance program and an organization to put it into effect. The policy of the department is to maintain existing traveled roads now on or approximating the routes of the state system. This gives immediate service to traffic and serves to keep roads passable while construction work is under way.

MODERN STREET LIGHTING

By C. F. Lambert, of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

Few people, not directly concerned in the lighting of streets, are consciously aware of the remarkable developments and improvements which have taken place in this connection within a comparatively few years. It is only observed by one who, accustomed to the splendid

illumination of a well-lighted city, visits a city whose street lights show a backwardness in keeping up with the pace of modern progress. The progress of a city in business, in attractiveness and in welfare is measured by its civic improvements. The original object in street lighting was to enable traffic to function without collisions or interference. Now, however, street lighting is an important element in crime prevention, a trade stimulant, and a means of expressing civic pride. That there is a direct bearing upon business development is shown by the active interest shown by Chambers of Commerce and other trade bodies in hundreds of cities, in the construction of brilliant illumination for their business sections. Large sums of money have been expended in this way by such bodies acting in conjunction with city authorities and electric lighting companies. The popular "White Way" lighting, which is almost universal now, had its inception through realization of the importance of good lighting as a trade factor. In many cases it has been the means of inducing people to pay regular visits from outlying districts to these brilliantly lighted cities, who came before only as necessity demanded.

Two Methods of Street Illumination

There are, generally speaking, two methods of street illumination: First, the high intensity lighting found in business sections of cities, which require an illumination sufficient to enable a large and fast moving volume of traffic to be handled without accident; second, low intensity and uneven lighting, as found in residence sections where objects, vehicles, etc., are seen in silhouette—usually as dark outlines against an illuminated street surface. As these streets are frequently lined with trees, it is necessary to place lights low to avoid the foliage. Therefore, residence streets are generally lighted to better advantage with low power lights at fairly close intervals, than by high power lamps at street intersections only. Generally, about three-fourths of the total lengths of streets in a city fall within this class. The still further outlying districts require merely a line of lights to indicate the way to travelers, and no effort is made for direct illumination.

Many Compromises Necessary

The many factors entering into the problem of street lighting require many compromises in attaining the final result. The desirability of a uniform design throughout a city should not be overlooked, especially in the lighting of a long thoroughfare which may extend from a business center to the outskirts. In such a case it may be necessary to sacrifice the requirements of certain sections, to some extent, to produce the proper effect for the whole. One factor that is frequently overlooked is the color of the street surface. The oiling of streets which had a light colored surface, frequently causes complaint of the street lighting and it is not always realized that the lower intensity is due to reduced effectiveness of the lighting with the dark streets.

Local Conditions Govern

Local conditions govern, to a large extent, the requirements for laying out a street lighting installation, and no definite rules can be made covering all cases. The amount and distribution of the light, the size of unit to be employed and the height and spacing of the lamps are all related and must be considered with other factors. Where there is no foliage, lamps should be placed well above the ground so that the maximum illuminated may be obtained at distant points. Care must be exercised, however, that the lamps are not mounted too high, as the uniformity would be gained at a sacrifice of intensity. The limiting factor for height and spacing is the amount of light obtained midway between the light sources.

Candle Power

When pendant or hanger types of units are used along the curb, lamps up to 100 candle-power should be mounted from 15 to 18 ft. high, depending somewhat on the light distribution. The higher candle-power sizes, i. e. 400, 600 and 1,000 candle-power, should be suspended at a height of from 20 to 25 ft. The spacing depends upon the uniformity of the illumination desired, and should seldom be greater than ten times the mounting height.

Lamp Spacing

For wide streets, lamps placed opposite one another will present the neatest appearance.

The staggered arrangement of lamps is sometimes advantageous in giving a uniform illumination, but will not be so attractive in appearance as where the lamps are placed directly opposite each other.

The arrangement of poles on one side of a narrow street is often very effective and economical, and is especially applic-

able to the lighting of parkways and suburban or residence streets. This arrangement is not suitable, however, for commercial streets.

In the low intensity lighting it is important that lamps be located at all street intersections; but with ornamental post systems, it is not desirable to place lamps directly on the corner, as the glare from such a lamp will tend to blind the driver who is about to turn the corner and wishes to see if the way be clear.

Care should be taken in any street lighting that the lamps appear in a continuous line, as any irregular placing of lights will detract greatly from the effect.

Intensity of Illumination

No definite figures have been generally accepted for determining the intensities of illumination most desired, and methods of comparing intensities of illumination of different types of light have not been standardized.

The final determination of intensity for street lighting depends upon the cost, and many other factors such as the surroundings and other local conditions. Comparison of practice in various sections and cities are useful in this connection. For similar units such comparisons may be made in watts per running foot of street; otherwise illumination or candle-power value of the same order may be utilized.

The proper diffusion of light by means of diffusing globes and refractors, is important in reducing the glare from bright light sources coming directly in the range of vision, and also eliminates the deep shadows. This is becoming of greater importance every day, due to the increasing brilliancy of modern illumination. The appearance of a light source is also greatly improved by the use of such equipment.

There are many different types of street lighting, including high and low candle-power pendant units, suspended from brackets or span wires, and ornamental post lighting with both high and low candle-power lamps. The system of energy supply to the lamps may be either multiple or series. Both systems can be installed underground or overhead. Of course, the greatest number of systems in this country are operated on the overhead series system.

The cost of installation and operation of street lighting systems is governed entirely by local conditions, and one is quite likely to be led to wrong conclusions if comparison is made of the prices charged in different cities, without a full knowledge of the local situation.

Important Details

Sizes of series lamps available for street lighting vary from 32 candle-power to 1,000 candle-power for use on a 6.6 or 7.5 ampere alternating current circuit. As the high candle-power lamps can be operated more economically at high currents, the units for the larger lamps are usually equipped with compensators or transformers. This permits their use in series with the smaller lamps.

Much skill has been shown in lighting of roads and highways. These are now being lighted by equipment which collects the rays and throws them up and down the road where needed. These units are mounted 30 to 35 ft. above the road and the glare which might naturally be expected to result is not apparent. The illumination of 250 candle-power units is excellent when placed 300 ft. apart and the lighting is good at even twice that distance.

At the intersections of highways, high powered flood lighting projectors are sometimes installed. They must be installed so that no glare reaches the motorists.

For outlying residence districts 40 to 100 candle-power lamps are popular and their height and spacing are adjusted to meet the conditions.

For the main residential section the lighting should be somewhat increased and lamps of 100 to 400 candle-power are utilized. A general plane of illumination comparable with that of bright moonlight and ranging from 1/20 foot candle to half or third of that amount is usually sufficient.

Summer resorts and cities having a high seasonal percentage of transient population require a highly ornamental type of residential street lighting fixture. This can be arranged so that a distinctive ornamental system may be had four months in the year and an adequate and economical system the balance of the time.

Business Street Lighting

In the main business section the art of street lighting has been most fully developed. Here the plane of illumination should be carried near to one-tenth foot candle, ranging perhaps from half of this amount at the darkest spots to at least double near the lamp. The most important streets and public places ought to

have an average of a good quarter-of-a-foot candle, giving light enough to read a notebook. Such lighting ought to be furnished in places out-of-doors where the public gathers at night, and in streets where the traffic is dense or the requirements for policing exceptionally severe.

In order to obtain the greatest usefulness and the most brilliant results, along a business street, most of the lights should be cut off from vainly trying to illuminate the sky. The buildings along the street should be well lighted from the street lamps and the street surface should be sufficiently illuminated to permit traffic to see clearly. Powerful arcs or large incandescent lamps placed fairly high, 18 to 20 ft., and spaced at a distance not over four or five times their height are very effective in securing these results.

In selecting the design of a standard for street lighting, local features and historic tradition can often be utilized. For instance, Los Angeles, Calif., has adopted a style suggesting the Spanish Renaissance. Riverside, Calif., has accentuated the Mission features of her spirit by installing a rough concrete post in the form of a chapel bell tower with three mission bells hung in a triangle, and a cross at the top of the design.

The requirements of cities which are far from the source of supply of standard globes, can be met with the lantern type of unit.

Thus, in modern street lighting the work of the architect and artist keeps pace with that of the electrical and illuminating engineer, so that every city may acquire a lighting system which will be adequate for the illumination required, and will be the pride of the entire community.

The foregoing is from a paper by Mr. Lambert before the 1923 Convention of the Municipal League of Indiana.

ROADWAY WIDTHS AS RELATED TO TRAFFIC

By L. R. Ash, of Harrington, Howard and Ash, Consulting Engineers, 1012 Baltimore Ave., Kansas City, Mo.

Traffic must go in lanes and the number of such lanes will be determined by the volume of traffic. On country highways and city streets the traffic follows the center of the roadway except when passing other traffic or when the traffic is dense enough to make turning out more troublesome than to keep continuously to one side of the road.

One Lane Pavement

In perhaps a majority of the highways of this country, except in the more densely populated districts, a 9 or 10-ft. pavement would be ample if shoulders were provided and maintained which would permit vehicles to pass. With a rule requiring the lighter vehicle to yield the road to the heavier, shoulders would be entirely adequate in the great majority of cases on the less densely traveled roadways. The writer recently traveled scores of miles on a highway in one of our southern states which has a paved roadway only 9 ft. wide. Although this highway carries rather heavy tourist traffic, during certain seasons of the year, little inconvenience was experienced in driving on it except for the lack of proper shoulders for passing other traffic. On this highway it was difficult many times to regain the pavement after having turned out to pass another vehicle. Proper shoulders which could be maintained at reasonable cost and which would add greatly to the stability of the pavement, would make this 9-ft. roadway adequate for present traffic. Very soon, however, the traffic on this highway will increase to such volume as to justify widening the pavement, but the road has given good service for many years and undoubtedly it was originally well planned and the 9-ft. pavement was the proper thing. A 9-ft. paved or gravel way would be a great boon to many communities which are struggling with the mud while awaiting the time when they will feel equal to the construction of wider pavements. A roadway 9 ft. wide, if properly designed and built, can be widened when the traffic demands it with the loss of only a small part of the cost of a pavement of standard width.

Two Lines of Traffic

When we pass from one to two lines of traffic, a roadway should be at least 16 ft. and preferably 18 ft. wide or even 20 ft. in some instances. If all vehicles traveled at the same speed the problem would be greatly simplified and a roadway 18 ft. wide would carry a traffic limited only by the miles per hour of travel. It is the necessity for making provision for the faster moving vehicles to pass the slower ones that complicates the situation. Since the rules of the road require that the faster moving vehicles, in passing other traffic in the same direction, give the right of way to traffic

in the opposite direction, the fast vehicle is forced to take advantage of gaps in the traffic which it meets. Fortunately, traffic has the tendency to form in groups, thus lengthening the gaps available for passage. Roadways designed for two lanes will carry a surprisingly large amount of traffic and undoubtedly the two lane roadway will carry more traffic per foot of width than any other. Recently the writer traveled about 100 miles on a concrete roadway 16 ft. wide, when there were probably 1,500 vehicles passing a given point each hour. The traffic was about the same in both directions. Of course there was some inconvenience from having to wait for a chance to pass more slowly moving vehicles, but the delay was not serious and had the shoulders on this road been in proper trim, the inconvenience would have been negligible.

Three Lines of Traffic

On a roadway wide enough for three lanes of traffic, one lane is really to facilitate the passing of the faster moving vehicles, unless the traffic in one direction largely predominates, in which case two lanes of traffic can be maintained and the third lane is for opposite travel and for passing. Very often we find roadways of widths that result in a very inefficient use of the pavement. For example, a roadway 22 to 26 ft. in width is only a liberal provision for two lanes of traffic, but is not adequate for three lanes. This wastefulness is especially aggravated if the roadway is on a bridge or viaduct, which is very expensive. For fast moving, modern traffic, a roadway 20 ft. wide is abundantly ample for two lanes of travel and it is a mistake to build a roadway 22, 24 or 26 ft. wide, since the result is still only two lanes of travel. The minimum width for three lanes of traffic should be 28 ft. and from 30 to 32 ft. is a liberal provision for three lanes. A roadway 34, 36 or even 38 ft. wide simply provides extravagantly for three lanes but is not adequate for four lanes.

As the lanes of traffic multiply, the resulting confusion requires a more liberal width for each lane. For instance, double the width necessary for two lanes will not provide equally adequate facilities for four lanes. A viaduct in one of our middle western cities, about 1½ miles long, has a roadway 30 ft. wide for about two-thirds of its length and 38 ft. wide for the remainder. A study of the rather heavy traffic on this structure demonstrates the inefficiency of a roadway 38 ft. wide as compared with one 30 ft. Traffic on this structure is never found in four lanes, although frequently the traffic is dense enough to utilize four lanes if the roadway were of the proper width. The roadway on this viaduct has handrails at the curb lines and it should be remarked in passing that a handrail or fence has the effect of reducing the effective width of a roadway..

A three lane roadway will accommodate a surprisingly large amount of traffic. A bridge in a New England state was recently completed having a roadway approximately one-half mile long and 28 ft. between curbs, there being a rail or fence along each side for the entire length. The resident engineer on the work reported that on the Sunday preceding last Labor Day over 10,000 and on Labor Day over 11,000 automobiles, other vehicles not counted, passed over the structure. The report states that this large amount of traffic was accommodated with a fair degree of comfort.

Forty feet is about the least width that should be considered for four lanes of traffic and for this and greater widths, the comfortable use of the roadway will be greatly enhanced by marking the lanes with painted lines or other means. This greatly diminishes confusion and prevents one lane from encroaching upon another's area.

After passing 40 ft. it is doubtful if the increments of width should be less than 20 ft., for on such heavily traveled thoroughfares the use of an odd lane is likely to be confusing and traffic so dense as to over-crowd a 40-ft. roadway will be none too comfortably cared for on a width of 60 ft. when due allowance is made for the natural increase of traffic.

Effect of Fences and Shoulders

On all roadways the condition at the side of the pavement with reference to fences or shoulders will materially affect the capacity. This is especially true on bridges and viaducts having fences or handrails. Drivers will not travel as close to a handrail or a fence as they will to the edge of the pavement, where there is no such construction. A roadway of given width with a sidewalk on either side will be used with greater facility than if there is a fence alongside. From observing traffic on roadways with handrails or fences, it would seem conserva-

tive to allow 2 ft. more in width where these are found than when they are omitted if traffic is allowed equal freedom in both cases. Also, if shoulders are maintained to the pavement level, traffic will pass more closely to the edge of the pavement or will even drive onto the shoulder, thus greatly facilitating the passing of vehicles.

Effects of Car Tracks and Vehicle Parking

What has been said thus far applies to roadways upon which there are no street car tracks and where parking is not allowed. Where there is one street car track and parking is allowed, the minimum width of roadway should be 44 ft. This allows 10 ft. for the car, 10 ft. for a lane of travel on either side of the car, and 7 ft. along either side of the street for parallel parking. Where there are two lines of street railway, the minimum width between curbs should be 54 ft. if parking is to be allowed. These widths will provide sufficient roadway for heavily traveled streets and where traffic is so dense as to require greater widths the increments should be not less than 20 ft. If there are no car tracks and parking is allowed, 14 or 16 ft. should be added to those widths designed for one, two, three, etc, lanes of travel. The minimum width of a street should be 24 and preferably 26 ft., assuming that parking will be allowed, and if a wider street is desired these widths should be increased by increments of 10 ft.

One-Way Traffic

In many cities the traffic has so outgrown the street widths that a remedy is sought in one-way traffic. Where the street has but one car line often this is a good solution, but where there are two car lines many difficult and dangerous situations arise with one-way traffic. Very often a rearrangement of street car lines would eliminate one track and thus make one-way traffic not only feasible but greatly advantageous over conditions where there is great congestion. A street so congested as to force traffic to move slowly will handle many fewer vehicles than would be possible on even a narrower street if the traffic lanes were kept open and traffic could move at a reasonable speed. Many times parking along the curb robs the street of its traffic capacity and changes the character of the district. Merchants have been known to object to the elimination of parking for fear it would curtail trade, when the real result has been to obstruct the roadway and add another strong inducement to trade in the suburban store. Nothing is so attractive to traffic as an unobstructed thoroughfare and it is quick to find it. Recently a street in Kansas City was practically deserted and the merchants were discouraged. After widening the roadway and repaving, the traffic is so dense that already traffic policemen are necessary to direct it.

Certain downtown streets in nearly every city are very properly used for parking and in this way they serve a most useful purpose, but the moment such use interferes with the free movement of traffic, parking should be prohibited and the streets which are kept open will be the popular streets. Narrow streets are causing a loss in business real estate in many cities out of all proportion to what an adequate street width would have cost had it been widened at the proper time.

There is every reason to expect a continued increase in the number of automobiles and the difficulty of providing adequate space for them will increase correspondingly. More and more congested areas must be kept free from the parked car and where possible the roadway width should be changed to permit automobile traffic to move at proper speeds. Often this can be done by moving curbs back 2 or 3 ft. on either side of the street and thus provide a width that will permit a speed of 15 to 20 miles per hour instead of 8 or 10. Street areas are expensive and the widths adopted should certainly be determined by the known requirements of modern traffic.

The foregoing matter is from a paper by Mr. Ash presented at the recent convention of the American Society for Municipal Improvements.

STREAM LINE FILTERS

By George W. Fuller, Consulting Engineer, 170 Broadway, New York, N. Y.

Stream line filters were one of the most interesting exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia, London, last month. They are the invention of H. S. Hele-Shaw, D.Sc., LL.D., F.R.S., a well-known inventor of mechanical appliances, a distinguished professor of engineering in earlier years at Liverpool and in South Africa, and last year President of the British Institution of Mechanical Engineers.

Historical

The principle of this filter was discovered last winter while experimenting with lantern projections to indicate the behavior of films under pressure in connection with the Theory of Stream-Line Motion, established by Dr. Hele-Shaw. Announcement of the discovery was made before the Royal Society May 10, 1923, and the formal paper attracted so much interest that this society requested a demonstration of its practical application at its annual soiree on May 16. So intense was the interest in the use of this highly scientific discovery that a second demonstration was given by request of the Royal Society on June 12. Descriptions and demonstrations were also given before the Royal Institution on June 1, before the Society of Chemical Industry on June 4, when a commercial-size filter was first shown, and before the Institution of Civil Engineers on July 12. So much for the antecedents of this device, which had been patented, prior to its exhibition before the general public at Olympia, August 31 to Sept. 22, 1923.

Operating Principle

The stream-line filter in its simplest form is made of a pack of specially prepared paper, impervious to water and oil and somewhat roughened to provide passage-ways, the pack being held within a container between two press-heads. One of the press-heads is movable and provided with a screen arrangement for suitably compressing the many hundreds of sheets which make up the paper pack. Through the entire pack from press-head to press-head are two alternate sets of circular holes, the larger being for the influent and the smaller for the effluent. At one press-head are channels through which, under pressure as desired, the influent is led to each of the openings of larger diameter; and at the other press-head are channels connecting with the smaller holes in order to remove the effluent. The influent, even under heavy pressure, can pass from the larger tubular openings only through the laminae of the heavily compacted pieces of paper, with stream line motion, into the smaller tubular openings which form an exit from the filter. The latter is equipped, at the press-heads, with rubber joints and other minor arrangements, which vary with the size of the unit and need no description here.

These filters are built of the horizontal or vertical type. The largest stream line filter exhibited at Olympia consisted of a battery of 16 vertical filters, each pack containing 16,000 sheets, 256,000 sheets in all, with 32 influent openings making the total number of filter units 8,192,000. Its rated capacity is 10,000 gals. per hour.

Cleaning

Stream line filters require cleaning at intervals, depending upon the quantity and quality of influent filtered since the preceding cleaning. This is done in one or both of two ways. Either the deposit on the walls of influent tubular openings is pushed through suitable ports in the press-head by means of light, free-fitting pistons which are actuated by the pressure normally used in forcing the influent through the filter; or, the deposit is removed by forcing the effluent back through the effluent openings, through the laminae of the compressed paper pack, thence through the walls of the influent tubular openings and out through a suitable port. Obviously the cleaning operations are to be adjusted to the work done by the filter. That is, consideration is given to whether the purpose is to obtain the separation of solids or colloids, or to free a liquid of undesirable matters contained in it. I saw several packs of paper dismantled after more or less use in filtering various substances and I was impressed by the complete absence of stain or other sign of service by the paper, other than at the edges of the influent openings.

Accomplishments of edge filtration, as distinguished from ordinary filtration through a body of granular material, depend upon the ability to regulate the attenuation of the films in which the liquid passes in stream-line motion. It is essential that the material used in this new filter have a rough surface so as to provide passage-ways, as satisfactory results do not appear to be obtainable with smooth surfaces. The special paper now used is not only impervious and relatively cheap, but its flexibility allows pressure to be applied to the packs in varying degree, thus providing a control for the size of the passage-ways. As a result of passing certain mixed liquids through the stream line filter several times, and increasing the pressure on the paper pack between each filtration, it is understood that different substances are removed each time, thus accomplishing what for convenience has

been designated as "fractional filtration." It may be mentioned that the paper in use is said to withstand ordinary acid solutions up to 10 per cent strength, but that filtration is interfered with by alkalies approaching 1 per cent.

Work of the Filter

As to the work which the stream-line filter will do, it is not easy in a few words to do justice to the discovery of Dr. Hele-Shaw. For present purposes it is sufficient to record some of its accomplishments, as follows:

Removes the color or stain from moorland swampy water.

Produces a colorless effluent from a solution of Erythrosin when diluted with 5,000,000 parts of water, and having a brilliant orange color with fluorescent green glint.

Produces from milk a clear effluent, nearly tasteless.

Extracts the oil from feed water.

Separates water and impurities from oil.

Extracts 30 per cent of the salt in sea water.

Decolorizes unrefined sugar.

Separates cyanogen from gas house sludge.

Reduces dilute activated sludge to a 60 per cent water content.

Enough has been said to indicate the wide range in style of performance which may be obtained from this discovery of Dr. Hele-Shaw. I have never seen an invention which has attracted so much favorable attention from such widely different groups of men. Its accomplishments have aroused not only those engaged in scientific investigations, but also the engineer, the chemist, the bacteriologist and the manufacturers engaged in many industries. Its commercial uses are being eagerly investigated at the same time that laboratory men are discussing its utility in their work. Discussions by English scientists have already suggested many interesting possibilities, including the grading of bacteria of different sizes, the concentration of enzyme solutions and the separation (by using sufficient pressure) of ultra-microscopic micro-organisms.

It is too early, of course, to say much as to the economic worth of this filter in the industries or to outline the scope of its benefits to science. But the indications are that it will have a bright future along many lines of activity.

As I left London a couple of weeks ago I was informed that an American company, to develop this invention in this country, was about to be formed, and that perhaps arrangements would be made to demonstrate its performance at the National Exposition of Power and Mechanical Engineering at the Grand Central Palace in New York, during the first week in December. However, announcements as to its introduction in this country will have to come from those having the matter directly in hand.

The foregoing paper by Mr. Fuller was read Oct. 16, 1923, at a meeting of the Engineers' Club of Philadelphia devoted to a discussion of the Pollution of Streams by Industrial Wastes.

HIGHWAY TRANSPORT, AN AID TO THE RAILROADS*

By Arthur H. Blanchard, President National Highway Traffic Association, and Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Michigan.

One of the most potent factors in the development of agriculture and industries, the growth of cities, the increase in wealth of states, and in the establishment of a sound basis for national prosperity is the efficient co-ordination of our railway, waterway, airway, and highway systems. Only by the development of a sound economic interrelationship between these four systems, will we obtain low rates, which will yield a reasonable return to the operators, and transportation facilities of maximum benefit to the public. It is of no benefit if a million bushels of grain have been produced in Kansas, if that grain can not be carried to market. As Senator Ransdell from Louisiana has said, "Prosperity is not helped because a bumper production of this or that is brought into existence, if transportation means be lacking to move it promptly and at reasonable charge to those who require it." The late Professor Alexander Graham Bell tersely summarized the value of our systems of communication when he said that "Transportation is the very blood-stream of civilization."

In this address will be found several quotations. It is, of course, practicable to express all of the opinions and con-

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* Address delivered at the Joint Session of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association in the Auditorium of the Michigan Agricultural College on Nov. 6, 1923.

clusions as personal views as the speaker has quoted no statements with which he is not in accord. In a brief discussion on a subject which today is controversial in the public mind, it appears worth while to bring to your attention the views of men prominent in National affairs or occupying positions of responsibility in the transportation world.

Views of Railway Leaders

About 15 years ago, James J. Hill, that pioneer in railroading, stated before a Committee of Congress that "Transportation demand was increasing so rapidly the railroads were unable to keep pace with it, and that in the near future our transportation facilities would collapse under the burden if we continued to rely solely upon the railroads to carry all the things that people produce." Vice-President Elisha Lee, of the Pennsylvania Railroad, has declared that "The next time our company has a real revival in business, we shall come, in all probability, to be confronted with the most severe congestion of railroad traffic and the most inadequate railroad facilities in our history. When that happens, rates will be lost sight of. Everyone will be clamoring for service. The whole country will demand transportation at any price; and rates will become so high they will cause great economic waste." On Jan. 20, 1923, Representative Newton of Missouri, on the floor of Congress, made this declaration: "The most serious commercial problem confronting the American people today is the problem of transportation. Our industries can not develop beyond the limits of our transportation facilities. When you shut down the machinery for transportation, you paralyze the industries of the country."

Railway and Waterway Transportation

In discussing the present interrelationship between railway and waterway transportation, Mr. Logan G. McPherson said in 1910 that "In the United States the railways demonstrated their superiority not only over the canals, but also over the rivers, in large measure displacing even the steamboats for which the Ohio and Mississippi rivers and their tributaries were famous."

This is a correct statement. Let us diagnose the methods by which it was accomplished. The following findings of the Inland Waterways Commission afford us the desired searchlight:

"While the decline of navigation in the inland waterways was largely due to the natural growth and legitimate competition attending railway extension, it is also clear that railway interests have been successfully directed against the normal maintenance and development of water traffic by control of water-fronts and terminals, by acquisition or control of competing canals and vessels, by discriminating tariffs, by rebates, by adverse placement of tracks and structures, and by other means.

"So large a portion of railway traffic is free from water competition that railways can readily afford so to reduce rates on those portions affected by such competition as to destroy the profits of the water lines without appreciably affecting the profits of the rail systems which recoup these reductions by higher rates elsewhere."

Attitude of Railway Officials Toward Highway Transport

What is the present attitude of railroad officials in the United States toward the development of highway transport? The answer is not a simple one to formulate as many diverse opinions have been expressed in words and actions. Some of our railroad officials appreciate the intrinsic value of highway transport and have made use of it as a part of their own transportation systems. Others have advocated its development because they know that it is necessaryt o the success of their business that facilities should be provided for economically transporting goods over highways to be later carried by railways. Others have been concerned regarding the development of highway transport from the standpoint of destructive competition with railroad transportation and have endeavored to curtail its development through legislative action. Others, and it is hoped that there are only a few in this class, have considered the subject from such a narrow viewpoint that they have advocated a curtailment of highway improvement.

Do we need to go further to realize the vital character of the problem we have under discussion and the necessity of developing in the minds of the people, our representatives in legislative halls and the operators of the four great systems of transportation that only through co-ordination of all and the enactment of legislation which will permit the efficient development of each agency will the public welfare best be served?

An Aid to Railroads

It may appear audacious to announce

bluntly that highway transport is an aid to the railroads, especially in view of statements frequently appearing such as that of one railroad president who charged a deficit of $4,856,000 to motor vehicle competition. Bald conclusions of this character appearing in the public press bring to the mind of the reader the much maligned motor truck tearing up the public highways. The public does not analyze the true meaning of the loss in revenue. It does not appreciate the large percentage of reduction of railroad receipts due to the operation of the family motor car. It does not know that some railroads are experiencing a reduction in gross revenue but would not suffer a loss in net profits provided that they efficiently used their facilities for the handling of those phases of transportation for which they are pre-eminently adapted to handle profitably.

The Lessons of History

The average citizen has lost sight of the usual consequences which follow the development of a new mechanical invention of benefit to mankind and the use of which contributes to national progress. Many railroad officials appear to have forgotten what happened to canal and river traffic and profitable commercial highway transport in the days when stages constituted the only common carrier for overland transportation. The disastrous effect on the balance sheets of canals, river and stage companies of the laying of hundreds of miles of rails wherever there was an evident field for bulk or mass transportation is a chapter in the story of railroading known to all.

Railroads Vital Part of Transportation System

Railroads are not going to cease to function because of the development of highway transport. The railways are and always will be a vital part of our transportation system. They, however, have an economic field which has clearly been defined by Professor Henry E. Riggs of the University of Michigan when he said at a convention of the National Highway Traffic Association that "Railway transportation for long distance business, and for all carload business where there is direct track connection to the factory or warehouse of the shipper is and always will be more economical than any form of highway traffic." The writer is an optimist and therefore believes that the American railroad official will see the light shining from the beacons of publicity and dissemination of knowledge and will soon administer his system of transportation with full recognition of the true value of highway transport to the railroads and the part which it will play in national development.

Feeders to Rail Lines

The railroads can render immediate valuable service to the public and to themselves by helping to direct the development of highway transport as feeders to rail lines and as extensions of rail service. A correct and immediate solution of the interrelationship between these two links of our national distribution system is very desirable in the interests of public welfare.

How Railroads Can Use Highway Transport

What are the opportunities for the railroad to function as an operator or user of highway transport?

First: The transportation of freight by motor trucks from one railway terminal to another in the same or nearby city. The advantages of the utilization of highway transport, as compared with the tedious method of rail transportation by "trap" or "transfer" cars over congested tracks have been appreciated by a few railroad officials. It has been established in some cities, notable examples being found in Cincinnati and St. Louis.

Second: The organized delivery with motor trucks of carload freight from public team tracks in large terminal areas. With such a system in effect, it has been stated that the present freight car equipment of the railroads would be sufficient to meet all transportation needs for several years to come.

Third: Extension of transportation service through the medium of motor truck and motor bus routes. There are several methods of development practicable in this field. Urban and interurban electric railway lines may logically expand their passenger transportation facilities through the establishment of tributary motor bus routes. During 1922 sixty electric lines throughout the United States used motor buses to supplement their rail service. Steam railroads may enter this field through the development of intercity and rural motor express lines to carry both commodities and passengers. One of the most notable examples is afforded by the highway transport services of the Great North of Scotland Railway Company which established its first motor truck service in 1904. In 1921

this railway company was operating five passenger routes and seven intercity motor truck routes. Railroads having stations in scenic areas may well give consideration to another development by the Great North of Scotland Railway Company, which operates from Aberdeen a motor bus line for tourist traffic.

Fourth: The collection and delivery of freight in municipalities and adjoining areas, which is similar to the methods universally employed in large cities for handling express shipments. This phase of highway transport would be a development of what is commonly known as the store door delivery plan. The ruling of the Interstate Commerce Commission in the case of the Baltimore development along this line means that it is impracticable for interstate railroads at present to use their own trucks in this manner except on such a large scale that the charge of discrimination in services rendered could not be brought against them. It is possible, however, to arrange with a large trucking organization to render this service. A development in Michigan is the plan of the Detroit United Railway to establish a pickup and delivery system with motor trucks especially equipped to carry box containers, one or more containers being used for the freight of one shipper. In England, we find railroads functioning as operators of highway transport in this field. One of the most notable examples is the case of the London & Northwestern Railroad's comprehensive system of freight delivery by motor trucks in areas with headquarters at London, Birmingham, Manchester, Liverpool and Leeds. This railroad established its highway transport service in 1905. In 1920 it was operating over 350 motor vehicles.

Branch Lines of Railroads

W. H. Lyford, Vice-President of the Chicago & Eastern Illinois Railway Company, believes that another field for the profitable use of the motor truck is the transportation of freight between communities which are served by branch lines of railway on which the traffic is too light to pay the expenses of any kind of railway transportation. He further says that no more such branch lines ought to be constructed if the highway transport operator will take over this field and occupy it intelligently and efficiently, and that money-losing branch lines along which transportation by motor truck over existing highways could be furnished at less expense should be abandoned.

To cut down operating costs on branch lines, 40 steam railroads are now using flanged wheel motor buses. Another development may be the reconstruction of the railroad roadbed as a private highway for the use of the railway company's trucks and trailers or its operation as a toll-road, which, if properly constructed without grade crossings for four lanes of traffic, could accommodate slow moving trucks and trailers and high speed motor busses.

L. C. L. Short Haul Freight

Elisha Lee, Vice-President of the Pennsylvania Railroad, goes a step further when he states that "The railroads still do a great deal of purely retail business. Some of it perhaps pays its way, but much of it unquestionably entails a loss. In the immediate vicinity of all our highly developed commercial and industrial communities, an immense amount of such traffic originates. A large portion of it moves only a few miles, but in its handling we are obliged to employ the most costly and overworked facilities which the railways own, namely, the yards and terminals in the great centers of industry and population. Here is a real opportunity for the motor truck to demonstrate its utility upon a true economic basis. The reason why less than carload traffic, especially on the shorter hauls, is becoming a growing burden upon the railroads is that we are obliged to use in it terminal facilities and rolling stock which are too expensive for the purpose and which of necessity must be primarily planned and adapted to the handling of bulk traffic, mostly moving over the longer hauls. Therefore I believe it to be at least probable that in many instances the short haul less-than-carload freight traffic could be turned over bodily to motor trucks with resulting advantage to the railroads and the patrons."

The views of state officials on certain phases of the interrelationship between railway and highway transport are indicated by the following excerpts from the 1922 Report of the Committee on "Motor Transportation" to the National Association of Railway and Utilities Commissions:

"Auto truck transportation meets a public demand in the rapid transit of less-than-carload shipments, including the door-to-door delivery element which

railroads have thus far failed to furnish. Railroad companies have exhibited a degree of indifference or slowness bordering on stupidity in recognizing and meeting demands of the public for quicker and more convenient movement of less-than-carload freight.

"It is evident if rail carriers hope to retain their short haul freight traffic, it will be necessary for them to make radical changes, both in service and equipment. Trucks are rendering an astonishing service between shopping centers and outlying trading points. Country merchants prefer direct truck service to the railroads even where the cost of the service is equal, for the reason that the trucks call at the wholesale house, receive the commodities desired and unload them at the store doors. This enables the country merchants to conduct business with a smaller stock of goods, for the reason that new supplies can be obtained conveniently and on short notice through truck service.

"Another respect in which truck service is preferable, is in the movement of household goods from one town or city to another. The principal expense in shipping by rail consists in crating the household goods and preparing them for shipping. In addition to the cost of crating, is that of cartage from the house to the depot and from the depot to the house. Furthermore, these additional handlings increase the loss and damage by breakage. It is difficult, of course, for rail carriers to meet this sort of competition, and thus far they have apparently made no effort to do so."

The cost of crating for railway shipment is well illustrated in the case of the transfer of the Davis Library of Highway Engineering and Highway Transport from Columbia University in New York City to the University of Michigan in Ann Arbor. The contract price for the crating of the library, the contents of which filled one freight car, was $1,000, while if the library had been transferred by motor truck, it would only have been necessary to box books and periodicals, the cost of which was $120. Another illustration is the case of the Remington Typewriter Company, which transports from its factory in Connecticut all of its typewriters consigned to New York City by motor trucks equipped with special compartment bodies. The saving in cost of packing is $1 for each machine or $300 for each truck shipment.

In closing, allow me to transmit to you the following pertinent message from our late President, Warren G. Harding: "The transport facilities of the whole world, whether by rail or by water, or whether represented by the great network of public highways, have been confronted with a most difficult situation for a number of years. It is one which demands the very best and wisest treatment from the standpoint of both the technical and economic and financial authorities. The whole program of transportation—in all its phases it must be regarded as that of a single problem—is among the most pressing and difficult that the entire world is facing today."

RELATION OF DEPTH OF FOUNDATIONS OF PAVEMENTS TO THEIR STRENGTH

By Clarence D. Pollock, Consulting Engineer, Park Row Bldg., New York, N. Y.

The foundation is a very important part of a pavement and is a considerable item in both the first cost and in the maintenance of the pavement and should therefore receive the careful consideration which it deserves. The foundation should be sufficient to transmit the load on the pavement surface to the sub-grade without material deformation and spread the load over a sufficient area of the soil so that its intensity does not exceed the safe bearing power of that soil. Too little attention has been paid to this portion of the pavement in the past, but with the much heavier loads of modern traffic more consideration is being given this matter. The Bureau of Public Roads has made and is now making tests to obtain more data in regard to the behavior of slabs under varying conditions of loading and impact and different conditions of sub-soil, and others have been working along similar lines, but there remains a great deal to be learned concerning this subject.

Manhattan Conditions

An old macadam pavement has proven a good foundation in many cases when it was not necessary to make openings in it for sub-surface structures, but usually in city streets the most satisfactory foundationi s one of Portland cement concrete, commonly mixed in the proportion, by volume, of 1 part cement to 3 parts sand and 6 parts of broken stone or clean washed gravel. This foundation is generally laid either 5 or 6 ins. in depth

upon a well compacted sub-grade. Where the sub-soil is sand or sufficiently porous material to provide good drainage, these depths have proven sufficient even for present-day traffic. For instance, in the Borough of Manhattan, New York City, with 6 in. depth of concrete foundations the Chief Engineer of Highways stated at the paving conference in Philadelphia in October, 1921, that for a considerable period the cost of repairs due to foundation failures had been kept separately and at that time it amounted to less than one-tenth of one per cent of the total cost of repairs per year. Any increase in depth of foundation here would surely be unnecessary and a waste of money.

Some cities have had a tendency to lay heavier foundations, but with good sub-grade material it would seem to be expensive insurance. It is true that New York has generally good sub-soil conditions, but it is an ever changing city and probably has more construction openings made in its pavements per mile per year than any other city. There is frequent settlement of the sub-soil in these cuts, but the concrete usually bridges over the moderate sized ones and carries the traffic. On Fifth Avenue it was found that 6 ins. of concrete foundation had bridged over a span of 6 ft. and had carried the traffic of that heavily traveled thoroughfare safely for years, although buses on that street, when loaded, weigh from eight to ten tons and carry from six to ten tons on the rear axle.

Improving the Subgrade

When the sub-soil is of clay or other material which can not be readily drained, from the present progress of tests it would seem advisable to improve the sub-grade rather than to weight it with a heavier foundation. In considering the bearing power of soils, a dry clay is usually capable of sustaining a load of 5 tons per square foot, but when very wet the same clay may not sustain more than 1 ton per square foot. By excavating a few inches additional and replacing with sandy or gravelly material the load will be spread so that with this and the better drainage a much greater load may be supported.

The foundation can not act as a beam until the sub-soil gives away sufficiently to allow it to act as such. The better the sub-soil, the greater the load required to deform the foundation. The Washington tests show that with the sub-grade support the sustaining power of the concrete foundation varies more nearly as the square of the depth than directly as the depth.

Measurements show that the foundation in transmitting the load to the sub-grade does not transmit it so that the pressure intensity is uniform. The pressure intensity is highest directly under the load, and spreads out over a considerable area, diminishing to nothing at some distance from the load. The intensity of pressure under the load must exceed the bearing value of the soil underneath before the foundation can act as a beam. Even a macadam, bituminous macadam or bituminous concrete foundation will not be deformed until the intensity of pressure directly under the load exceeds the bearing value of the sub-soil. If the load is stationary or if the surface of the pavement is very smooth there will be simply the static pressure, but if the surface of the pavement is a little rough there will be impact and if the surface is quite rough this impact may amount to four to five times the static pressure. This is greatest when the tires are badly worn; with good, well-cushioned tires the impact apparently approaches more nearly the static load, and hence the advisability of securing as uniformly smooth a surface to the pavement as possible in order that the impact of moving loads may be eliminated as completely as can be done.

What Tests Show

In the Bureau of Public Roads tests with slabs on wet and dry soils, the impact tests punched through the 4 in. slabs, but those of 6 ins. in depth and greater were simply cracked on up to those 10 ins. thick, which could not be broken by their apparatus even on the wet sub-grades. According to this a thickness of 10 ins. should be sufficiently great to carry any load that might come upon the pavement even with a wet sub-grade which may be more or less plastic. However, we are not so likely to have wet sub-grades in city streets subject to heavy truck traffic as the pavement is usually impervious to water and likewise the sidewalks are generally paved so that there is much less likelihood of sub-soil troubles here than with suburban roads. But should there be bad sub-soil conditions, in general it will be found much less expensive to improve the sub-grade than to pay for 4 extra inches of concrete in addition to the extra grade removal which alone would in most cases

be sufficient when replaced by a more porous coarse grained material which is not affected materially by water as are the very plastic soils such as many clays. With proper support from the sub-soil and a reasonably smooth surface to the pavement, a thickness of 6 ins. for the concrete foundation seems adequate especially as most heavy loads are now hauled on motor trucks having rubber tires. The trucking interests have found that it is not economical to carry loads in excess of about 750 lbs. per inch width of tires. This insures wide double and triple solid rubber tires on each rear wheel and a good distribution of the load over the pavement so that by the time it is spread through the thickness of the pavement and the concrete foundation the pressure intensity is usually well within the supporting value of the soil. Some states have limited the loads permitted on their highways, but here we have a limit placed by the effect on the truck owners' pocketbook, which is more easily enforced than the other.

Supporting Power of Foundations

When in exceptional cases it may be necessary to use a greater depth of concrete than 6 ins., it should be remembered that the supporting power of the concrete foundation varies about as the squares of the depths, as for example, 7-in. depth concrete would have about one and one-third the supporting power of 6-in. concrete, 8-in. concrete one and three-quarters, 9-in. concrete two and one-quarter and 10-in. concrete three times nearly the supporting power of 6-in. concrete. By keeping this in mind it should prevent wasting money in using too great an increase in depth in special cases.

Another matter that the tests have brought out is the fact that while the compressive strength of 1:3:6 was 50 per cent of that of the 1:1½:3 concrete, the difference between the beam and slab strength of these two mixtures did not exceed 20 per cent.

Damage by Water

In addition to damage from heavy loads the pavement, including its foundation, may be injured by water entering a clayey or other plastic sub-grade material from terraces or sidewalks and lifting and cracking the foundation and pavement by the swelling of the sub-soil. Sometimes this may be caused by frost heaving the foundation when there is a large amount of water in the plastic soil under the foundation. During the past season the writer was engaged upon an examination of some breaks in foundation and pavement where a study of the conditions shown by openings and the history of the breaks as to when they were noticed after the completion of the pavements and before freezing weather and the soil condition in the terraces on the uphill side and the clay of the sub-soil showed conclusively that the breaks were due to the soil conditions and not to any loads to which the pavement had been subjected. These are further reasons for improving the sub-soil rather than increasing the depth of the foundation, as a considerably heavier foundation would have probably been broken by the heaving of the clay when it becomes wet, and if not by this then later by the action of the water in the sub-soil freezing, and lifting the pavement. About 20 years ago the author had several streets paved with asphalt on concrete foundation in a suburban development, where there was a layer of clay directly under the foundation and back of the curbs there were wide grass plots. A severe winter followed a wet fall and caused this pavement to be lifted as much as 2 ins. in places as evidenced around sewer manhole heads. After the frost went out of the wet clay the pavement settled back, but unevenly and cracked badly in so doing. Since that experience he has been very chary about placing the foundation directly on clay or other plastic material if there was any chance that water might penetrate it, whether in a cold or in a warm climate, as water alone will cause it to swell and lift the foundation and frost will increase its volume still more.

Six-Inch Base Recommended

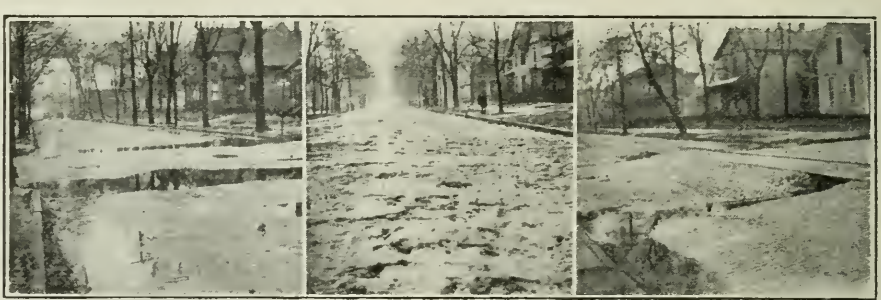
From our present knowledge we believe that a 6-in. depth of foundation is sufficient to carry modern traffic, provided the sub-soil is good, and if it is poor that it is better to improve the sub-soil rather than to use additional concrete in such cases.

The foregoing paper by Mr. Pollock was presented at the recent annual meeting of the American Society for Municipal Improvements.

IMPORTANCE OF ADEQUATE STREET DRAINAGE

By Harlan H. Edwards, C. E., Pasadena, Calif., Formerly City Engineer, Danville, Ill.

Adequate street drainage is of great importance in our cities and towns, for thousands of dollars are lost or wasted each year because of the lack of a way to get the rainwater off the streets quickly. Adequate drainage permits pavements to be constructed without ditches or gutters across them at every intersecting street. It permits travel on our earth streets much sooner in wet weather than could be otherwise done. It prevents the flooding of surrounding property by the backing up of water during heavy rains. It prevents the saturation and eventual destruction of pavements by standing water and, finally, when street slopes and sewers are properly located, the pavements are cleaned by the rains, thus saving many dollars that would be otherwise spent on shoveling and hauling away street dirt.



SOME EXAMPLES AND RESULTS OF BAD STREET DRAINAGE.
Left and Right: Old Style Extension of Gutters Across Pavement at Street Intersection. Center: Debris Left on Street Pavement by Storm Water

The absence of underground sewers or storm water drains is an absolute damage to any community. It brands the city as a "back number"—a place where public improvements are not appreciated, and as the home of unprogressive citizens. Surface drainage of all streets means the turning of some pavements into open sewers during rainy times. It means the ever-present danger of overflow in the lower portions of the unsewered district, while in any event, the receding waters always leave the street littered with debris of all kinds, which has been brought down by the waters from the streets and alleys above. Great inconvenience is caused pedestrians by this heavy surface flow of water, sometimes even making necessary the use of boots in travelling the lower portions of the city. In fact, large sections of pavement have been known to float away during excessive and prolonged rains. It is seen, therefore, that some means of quickly removing the storm water from the streets is a necessity in all progressive communities.

Adequate drainage, therefore, is best accomplished by a complete system of sewers, into which the rainwater can be directed from the streets at frequent intervals. Cast iron inlets placed at every street intersection and at intervals along the street in long blocks direct the water quickly into the sewers, and permit a better arrangement of street slopes or grades. The steeper these grades can be made, the faster the water will move along the gutter exerting a sort of scouring action upon the street and gutter, washing the dirt off through the sewers. Where pavements and sewers can thus be planned together, many dollars can be saved in future street cleaning. This saving alone, if properly taken into account, would go far toward paying back the original cost of the sewers..

The elimination of cross gutters is another thing which the installation of sewers permits. In years past, when horse-drawn vehicles were the only ones using the streets, gutters extending across the street intersections were not considered objectionable. Now, however, swiftly moving vehicles find such gutters actually dangerous and a menace to travel. Some streets are really impassable to vehicles travelling faster than a walk on account of such gutters as are shown in the photograph. Things like these should be eliminated by the building of sewers, in the interests of public safety, if for no other reason.

They are dangerous to traffic, unsightly, and a public nuisance.

Some cities are blessed by the possession of good natural slopes to their streets, yet few have taken advantage of this as an aid to clean streets. Few people seem to realize that where properly used, money invested in sewers will return a handsome profit to the investor, in future savings. Since they are unseen, they are unthought of, yet when once installed, the first cost is the whole cost. They are permanent, they require very little attention or maintenance, yet they are always active in the service of the public.

EFFICIENT FIRE PROTECTION AND PREVENTION

By Frank C. Jordan, Secretary, Indianapolis Water Co., Indianapolis, Ind.

The curtailment of America's fire losses is one of our most serious problems and demands the attention of our ablest citizens. Shortly after the war, our fire losses began to climb with astounding rapidity toward the $500,000,000 mark. Last year they reached this point—reached it and kept on soaring until they registered a total of $521,860,000. This sum exceeds that of any other year even including 1906, the year of the San Francisco conflagration. No great conflagration marked the year 1922, our immense loss for that year being the result of thousands upon thousands of fires, some of them insignificant, but all contributing to a total of immense proportions. Inflated property values have played a part in raising the total; likewise the congestion of population in a comparatively small number of cities. But losses by fire have greatly outstripped the growth of population.

In 1912 the United States Census Bureau reported a total population of somewhat over 95,000,000, and the per capita fire loss was $2.16. Ten years later, the population had increased but 15 per cent, while the average per capita fire loss amounted to $4.75, an increase of more than 100 per cent.

The fire losses in Great Britain during the year 1922 totaled $30,812,000, as compared with our fire loss of $521,860,000. The population in Great Britain in that year was 45,000,000, as compared with our 111,000,000. Great Britain has been showing a reduction in its fire losses, and its per capita for 1922 was 72 cts., as compared with our per capita of $4.75.

Public Carelessness

A careful survey of the causes leading to our fire losses proves conclusively that the largest part of the humiliating fire record of 1922 was the product of public carelessness. If the fire losses in the United States continue at the rate established during the first nine months of 1923, our country will suffer a fire loss of more than $5,600,000 during the period of three days. The loss of life by fire will be approximately 146, and in addition thereto 170 citizens of our country will be so seriously injured by fire as to be made unfit for active duties, in this 3-day period. To the staggering waste of life, health and wealth, our state contributes a certain portion, and it is to the proposition of decreasing that portion that I would call attention.

The fire losses can be materailly decreased if we will build a thoroughly efficient public fire service and couple with that a systematic training in Fire Prevention.

Grading Cities

In grading cities with reference to their fire defenses and physical conditions, certain standards have been adopted and a plan has been worked out for grading the cities according to the deficiencies existing in the various departments. The sum of the maximum points of deficiency totals 5,000 and is divided in accordance with the relative values of the features as follows:

Water supply	1,700 points
Fire department	1,500 points
Fire alarm	550 points
Police	50 points
Building laws	200 points
Hazards	300 points
Structural conditions	700 points

That is, a city where the fire defenses and physical conditions are excellent, would have few points of deficiency and one where conditions are as bad as possible would approach 5,000 points. You will note from these figures that the water supply is given a weight of about one-third of the total requirements. An adequate water supply is considered as being of slightly more importance than an adequate fire department, as a water system is of some value for fire protection where there is no organized fire department but a fire department without water is almost helpless. You will

further note that the official city is charged with 2,300 points in this grading, namely, 1,500 for the fire department, 550 for the fire alarm system, 50 for adequate police supervision and 200 for building laws. The public is, generally speaking, charged with 1,000 points, 300 covering hazards and 700 covering structural conditions.

Water Supply

The water supply is judged from two viewpoints, adequacy and reliability, and a failure to measure up to both of these requirements will mean an inadequate public fire protection service. In grading a water system, deficiency charges are made under 32 separate headings. Time will not permit of a detailed statement covering all of these, but a reference to a few of them will be well worth while. The chief executive, either superintendent or chief engineer, shall be competent and qualify by experience. Employes shall not be subject to removal by every incoming political administration. Records and plans shall be such as to facilitate repairs and to permit of the efficient operation of the system. Emergency crews shall be quickly available; fire alarms shall sound in appropriate water works quarters. Sufficient water shall be available to furnish thoroughly adequate service, including the full required fire flow. The pumping stations and pumping units must be well designed and constructed and must be kept in good working conditions. The pumping capacity must be such as to provide for adequate reserve. The distribution system must be installed in accordance with best engineering practice, and the material used must be of such quality as to withstand the hard service to which it will be subjected. The system must be properly valved and there must be such a spacing of fire hydrants as will give a proper degree of public fire service.

Fire Department

The fire department is graded as follows:

Fire Department:

1. Equipment—Kind, amount and distribution of equipment, degree of serviceability and installation of standardized couplings.
2. Personnel—Paid or volunteer, number, fire methods used, morale.
3. Organization and Supervision—Inspections, reports, records, company organization.

Fire Alarm System:

1. Equipment—Type and extent of equipment, location (as regards disablement by fire), number of telephones.
2. Organization and Supervision—Operation of system, maintenance, personnel.

Other features, including private plant protection, outside emergency aid, willingness of the police department to cooperate, etc., are taken into account in the grading.

A large number of cities throughout the United States have been graded in accordance with these standards, and many cities are making an honest effort to strengthen the weak parts in their public fire protection service and bring their various departments to a high degree of efficiency. It is, however, very significant that the leading fire protection and fire prevention organizations deem it necessary to pass resolutions year after year calling our attention to the value of a careful study of these deficiency items and a compliance with those recommendations which would lead to a more efficient fire service. For many years past the annual conventions of the National Fire Protection Association have adopted resolutions advocating certain measures in their warfare against the needless sacrifice of human life and property by fire, and these resolutions were again adopted at the 1923 convention held in Chicago in May. These resolutions cover twelve important items of fire protection and prevention, but the time allotted for my paper will not admit of a careful study of every one of these. I would, however, direct your attention to five of these paragraphs.

Important Items in Fire Protection and Prevention

1. A careful study of the technical surveys of cities made by the engineers of the Committee on Fire Prevention of the National Board of Fire Underwriters, covering the items of water supplies, their adequacy and reliability, fire department efficiency, fire alarm systems and conflagration hazards, and of the possibility of co-operation among neighboring cities through mutual aid and the standardization of hose couplings. The organization of local fire prevention committees to promote these objects.

2. The systematic inspection of all buildings by city fire marshals or local firemen to insure the vigorous enforce-

ment of rules for cleanliness, good housekeeping, and the maintenance of safe and unobstructed exits, fire-fighting apparatus and other protective devices, and to enable firemen to become throughly familiar with the essential structural and other features of buildings which it is their duty to protect.

3. A more general legal recognition of the common law principle of personal liability for damage resulting from fires due to carelessness or neglect, and the enactment of laws or ordinances fixing the cost of preventable fires upon citizens disregarding fire prevention orders.

4. The education of children and the public generally in careful habits regarding the use of fire, and the general adoption by the schools of the United States of the fire prevention manual, "Safeguarding the Home Against Fire," prepared by the National Board of Fire Underwriters with the assistance of the United States Bureau of Education.

5. The adoption by municipalities of the standard building code of the National Board of Fire Underwriters, to the end that fire-resisting building construction may be encouraged, the use of inflammable roof coverings prohibited, adequate exit facilities from buildings assured, and interiors so designed and fire-stopped as to prevent or materially retard the development and spread of fire therein.

Practically the entire story of efficient fire protection and prevention is covered by these recommendations, namely, a careful survey of our fire fighting facilities, a systematic inspection of all buildings, the enactment of personal liability laws, the education of the public in regard to fire prevention measures, and the adoption of a standard building code.

Fire Prevention Program in Indianapolis

During the past three years, the city of Indianapolis has been engaged in a fire prevention program which has attracted nation-wide attention. The success of this program has been due to the fact that those in authority have given most careful thought to the important items referred to in these five paragraphs. The Indianapolis Water Company, with which organization I have the honor to be associated, has given most careful consideration to the question of adequate service for public fire protection. For years the company has pursued a liberal policy in reference to its water main extensions, adequacy of plant equipment and water supply, hydrant installations, etc., and for years it has been making a whole-hearted effort toward complying with all reasonable requirements relative to public fire service. The company has availed itself of the most competent engineering advice, and has followed this advice in carrying forward its program of construction. During the year 1923 our construction expenditures will total approximately $1,000,000, and a large portion of this expenditure is directed primarily toward furnishing a larger volume of water for fire service. I bespeak for every water plant of the state such a broad-gauged policy as will make possible the building of a plant which will be able at all times to furnish a thoroughly satisfactory water service both for public fire protection and domestic consumption.

The city of Indianapolis has purchased thoroughly modern fire equipment, and the responsible heads are making a concerted effort toward furnishing a high-grade public fire service.

Under the supervision of Fire Chief O'Brien and Mr. Jacob E. Riedel, chief of the division of fire prevention, a systematic inspection is being carried on in the city of Indianapolis, which in its degree of efficiency is second to none in the United States; 41 firemen are engaged in this work, and these firemen are not only rendering a valuable service in helping to prevent fires, but they are becoming thoroughly familiar with all of the properties in their neighborhood, thus adding to their efficiency.

Attention is directed to the thought that in future years our fire departments will devote more time and energy to the prevention of fires and less to putting them out once they have started. This will not be as spectacular as fire fighting, but it will be much more efficient.

The fire department has a well equipped drill school and training college, and this school is contributing largely to the efficient handling of the fire department equipment and to the curtailment of our fire losses. This work commends itself to the careful attention of every one interested in the subject of efficient fire protection. It is one of the most important features of the modern fire fighting organization, and has not received the consideration which its importance warrants.

The responsible authorities are making a concerted effort toward the elimination of the indiscriminate use of the public

fire hydrant, it being found that the use of the public fire hydrant by other than trained firemen leads to frozen or broken hydrants with a serious diminishing of the efficiency of the public fire service.

You may feel that your water plant superintendent is "cranky" when he enters a strong protest against the use of the public fire hydrant by street and building contractors, street cleaning and flushing gangs, etc., but the fact remains that such use leads to a serious decreasing of the efficiency of the public fire service and must be discouraged.

The Fire Prevention Committee of the city of Indianapolis has given considerable thought to the question of personal liability for damage resulting from fires due to carelessness or neglect. The committee has been responsible for a considerable amount of publicity in reference to the enactment of a personal liability law, and it is our hope that such a law will be enacted and enforced, with a resulting decrease in Indiana's fire losses.

Hundreds of thousands of pieces of fire prevention literature have been distributed through the Indianapolis schools; scores of city firemen in uniform have delivered fire prevention addresses before school children, luncheon clubs, etc.; excellent moving pictures showing various phases of fire prevention activities have been shown in all sections of the city, and through these, and other measures, the Fire Prevention Committee has attempted to make the public realize that a certain share of the responsibility for fire prevention rests upon their shoulders.

Our city has adopted a standard building code, and in addition thereto has passed an ordinance which is doing much toward eliminating one of our greatest fire hazards, namely, our wooden shingle roof. Other cities of the state are giving serious thought to the question of efficient fire protection and prevention, and it is a notable fact that Indiana was one of the very few states in the Union which showed a reduction in its fire losses during the year 1922.

The foregoing is from an address by Mr. Jordan before the recent annual convention of the Municipal League of Indiana.

CONFERENCE ON HIGHWAY BUILDING COSTS AND CONSTRUCTION PRACTICES

Factors in reduction of highway building costs and improvement of construction practices are to be developed when committees appointed by the Associated General Contractors of America and the American Association of Highway Officials meet for conference in New Orleans, December 3.

A strong element of public service is involved in the discussions to be held, as the creation of closer co-operation between highway engineers and contractors is logically to be expected to result in a maximum return for funds expended in highway construction.

The New Orleans meeting will have as its duty the translation of policies agreed upon by the two organizations during the past year into terms which may be directly applied to practice in the operations of state highway departments. Those who are leading the move for standard highway contracts and specifications see the conference between these two committees as an opportunity to gain the goal toward which such marked advance was made when the initial outlines of policy were adopted.

Commenting in this connection, Henry H. Wilson, member of the Advisory Board of the Associated General Contractors, and also a member of the committee which will represent the contractors at the New Orleans meeting, recently expressed himself and the views of his associates as follows:

"Many highway constructors who have long labored for the upbuilding of their industry, both ethically and economically, and who were convinced that real progress could only be achieved through the establishment of a degree of concord and action between public officials, engineers and constructors, whose benefits to the taxpayer would be unquestionably demonstrable, hailed the adoption of those policies last year as the harbinger of a new and better day in road building.

"Let us hope that there may proceed from the coming conference at New Orleans a vigorous and dynamic stimulus to every public official, engineer and constructor in the country to pool their purposes and make the policies already adopted (or to be adopted hereafter) accomplished facts everywhere. The old Roman fable of the body and its mem-

bers is peculiarly applicable to the relations of public officials, engineers, constructors, taxpayers and all others interested in highway building. If the coming conclave of the committees does nothing more than accomplish a real working union of the members of this fabled 'body' which will enable it to find its 'feet,' the meeting will be epochal. If this result is achieved it can be said in future years (somewhat in the words of the great Webster) that the meeting smote the rock of co-operation everywhere and abundant streams of benefit to all gushed forth."

THE PROBLEM OF HIGHWAY FINANCING IN AMERICA

By A. R. Hirst, State Highway Engineer, Capitol Annex, Madison, Wis.

The American people are living through the greatest transportation miracle of all time without in the least realizing that the miracle is taking place; without computing the cost of it, and without computing the cost of supplementing it by another miracle just as astounding in its scope and magnitude. Not one in ten thousand has the slightest realization of the economic, social and engineering problems presented by these twin marvel episodes—the development of the motor vehicle and of a highway system to meet the needs of it.

America passed through its first episode of highway building from 1800 to 1830; through its great era of canal building from 1810 to 1840; its great era of railroad building from 1850 to 1880. Its second great era of highway building commenced with faltering steps about 1890, attained some proportions about 1910, is now almost in full progress, with the probability that the major portion of the episode of constructing a modern highway system will take place between 1920 and 1940.

The Growth of Motorization and in Highway Expense

The figures indicating the development of motor vehicles and of motor transport and the parallel development of highway construction and maintenance are so astounding that they have passed almost unnoticed. Even the statistics showing the progress of the motorization and of the highway enterprise have hardly been kept. When one seeks to recover the facts of only a decade or two ago, he finds great difficulty in placing his hands on figures which are dependable. There are, however, available some figures which sketch the steps of the development of the motor vehicle and of highway expenditures in the last two decades with sufficient detail and accuracy for our present purposes. The four years used were selected because the United States Bureau of Public Roads had quite carefully collected the figures of national highway expenditures for three of them, viz: 1904, 1914 and 1919. Further, 1904 marks about the end of the period before the modern motor vehicle and highways era; 1914 the first beginnings of a real American highway construction program; 1919 the resumption after the pause due to the war, and 1923 the well started modern highway program.

In 1904 there were in operation in America about 58,000 automobiles. There were practically no motor trucks. In 1914 there were registered 1,711,339 automobiles and motor trucks. In 1919 there were registered 7,530,105 automobiles and motor trucks. In 1923, preliminary figures indicate a total registration of at least 14,000,000 automobiles and motor trucks.

In 1923 the people of at least 40 American states own and operate more motor vehicles than there were in all of America in 1904. In 1923, in New York and California combined, or in Ohio and Pennsylvania combined, there are owned and operated more motor vehicles than there were in all of America in 1914.

In 1904 the rural highway expenditures of America are reliably computed to have been $59,527,000; in 1914, $240,264,000: in 1919, $389,456,000, and in 1923 they are estimated to be at least $800,000,000. Roughly, the rural highway expenditures per motor vehicles in operation in 1904 were about $1,026; in 1914, $140; in 1919, $52, and in 1923, $57. The expenditures per motor vehicle in 1923 were 5 per cent of those of 1904; 40 per cent of those of 1914, and 110 per cent of those of 1919.

Fourteen million motor vehicles in 1923! The investment of the American people represented in them is probably ten billion dollars. The annual cost of owning and operating them was undoubtedly $5,600,000,000. This is nearly two billion dollars more than all taxes, exclusive of federal taxes, and over one-half of all taxes, including the federal taxes! They were operated a total of at least fifty-six billion miles. These last two figures, it will be noted, give 10 cts.

per mile as the average cost of operation, which is conservative.

If we could, through the development of a real system of highways, reduce the operation cost of motor vehicles 1 ct. per mile (as we can), the annual saving to motorists would be $560,000,000. This capitalized at 4½ per cent would represent an investment of about $12,500,000,000. This could be proven to be a profitable outlay on this one item of saving alone.

One filling of their fuel tanks, even at present prices, costs the proud owners about $27,000,000. If each should lose a casing and tube, the cost of replacement, at a weighted average of $20 each, would be $280,000,000.

The above paragraphs are written with the idea of showing the large figures which must be dealth with when we touch anything which relates to motor vehicles. This immensity must always be borne in mind when considering the problem of developing highways for motor transport.

We are not going to speculate very much on what may be the further development in the use and operation of motor vehicles. When the percentages of increase in the number of motor vehicles made and sold in the last two years are considered, it is quite sure that the end of motor vehicles increase is not yet near. At the end of 1916 there were 3,513,000 motor vehicles registered in America. At the end of 1923, 14,000,000. The numerical increase for the six years, 1917 to 1923, inclusive, was 10,487,000. It seems well within the bounds of probability that there will be a numerical increase of 6,000,000 in the six calendar years, 1924 to 1930, inclusive, so that by the end of 1930 there should be owned and operated at least 20,000,000 motor vehicles. This naturally makes the problem of providing highway service for them loom even larger than the present registration figures indicate.

Even with the meager figures available, a paper of much more length than has been assigned this one could be prepared bringing out the twin wonders of motor transport and of highway development, but we must leave these interesting speculations to other times.

The Financial Problem

It must be quite obvious from the above summary of the momentous developments in highway transportation in the last two decades that there has been precipitated upon the American people a problem in public financing unparalleled in the history of the nation. Financing the public schools, colleges and universities involves practically as much public money as highway work does. But the public schools have been a process of slow development, speeded up, it is true, by modern demands during the last two decades, but still a slowly developing growth of and from the basic American idea of free public education. The machinery of school administration is the growth of over a century. That the public schools must be supported by the whole people largely in proportion to their wealth is established.

The problem of highway financing has been forced upon us almost over night due to the unparalleled demands for transportation service and for highways. Taxation for highways in America for 1904 was practically a negligible factor in the total taxation. In 1923 it has reached such proportions that in many states it is nearly one-half the total tax bill of all units of government. Obviously, such an unexpected and unwelcomed increase in the obligations of government must demand especial consideration and special treatment.

It is not as if the other obligations of government were being reduced. It is not as if other public or private expenditures of the American people were being reduced. The cost of our government service to water-borne transportation is not decreasing; the cost of our railroad service is not decreasing. "On the contrary," as the polite Frenchman replied when asked on a rough morning on shipboard whether he had breakfasted. In addition to all of these former costs of transportation, we are in the midst of a most wild and exotic growth in the amount expended for personal transportation and in road service to take care of this increase in personal transportation.

We have stated that the cost to the American people of owning, operating and depreciating motor vehicles in 1923 was at least $5,600,000,000. This is in addition to the cost of constructing and maintaining highways and bridges in all units of government, which must have been $1,000,000,000. There are offsets to this new bill in that there are more people to be served with transportation, probably less expenditure for transpor-

tation by horse-drawn vehicles, and a greater volume of goods to be transported. But, it is an increase of at least $6,000,000,000 in our annual bill for highway transportation—largely for added highway transportation for persons—over the bill of 1904.

Whether the American people can afford each year to expend six billion dollars more for highway transportation than they did in 1904, we will not discuss. We will discuss the rural highway bill of America for 1923 as compared to the rural highway bill of 1904. The bill of 1904 was $59,500,000, and of 1923 is $800,000,000. The difference is $740,500,000. In general, the only difference between the highway conditions of 1904 and of 1923 is that in 1904 there were practically no motor vehicles, and in 1923 there are fourteen million of them. The change in the situation has been brought about almost wholly by the astounding increase in the transportation of persons and goods by motor vehicles. The increase in the cost to government, due to the American people's possession of motor vehicles has, therefore, been for rural highways alone (disregarding the very largely increased costs imposed upon the cities and villages) approximately $740,500,000.

In 1904 the motor vehicle paid toward the cost of highway work in America practically nothing. In 1923 the taxation upon motor vehicles other than the government luxury tax, which has no bearing up the financing of highway work, is probably $300,000,000. Of this, probably $100,000,000 is paid as a personal property tax not dedicated for use on highways, while $200,000,000 is probably paid in license fees, franchise taxes, gas taxes, etc., the proceeds of which go largely to highway uses. In other words, as an especial class of property signally benefiting from highway development, the motor vehicle is taxed for the construction and maintenance of highways in 1923 approximately $200,000,000. (This is 3.6 per cent of the total cost of owning and operating them in 1923.) Disregarding as negligible the taxation on motor vehicles for highways in 1904, it is $200,000,000 more than they paid in 1904. The increase in the rural highway bill between 1904 and 1923 is above shown to be $740,500,000. Therefore, the motor vehicle is charged in taxes, paid due to its use of highways and not due to its existence as a luxury or to its existence as a piece of personal property, about 27 per cent of the additional cost of constructing and maintaining rural highways imposed upon government by its ownership and use. Please, again, remember that the added costs (and they are great) imposed upon cities and villages by motor vehicle ownership are not included in the above figures.

Who Shall Pay the Highway Bill?

Of course, those who believe that the motor vehicle is already overtaxed will contend that other causes have led to the increase in the highway programs, but this other urge has been so small as to be negligible. In a broad summary, such as this, we are certainly justified in saying that the increase in the American highway program of today over that of 20 years ago is caused by the ownership and use of motor vehicles. We know that every plan for highway construction or maintenance; every relocation; every bridge design; every plan for highway systems and layouts; in short, every highway problem of nation, state, city and county originates with and has its conclusion drawn from a study of the present and future demands of motor vehicle traffic.

In national, state, county or city legislative bodies or highway organizations there is no discussion of roads, streets or bridges which does not hinge on the necessities of the motor vehicle. The horse and the horse-drawn vehicle have practically disappeared from consideration, and in not one phase of modern highway development does the presence or the absence of the horse have any real bearing. In ninety-nine cases out of a hundred, horse-drawn traffic is given as little consideration as is the number of dinosauria and mammoths who may traverse the highway. We are a motorized people, dealing with a problem of motorized transport and commencing to pay the bill for motorization.

It is also urged by the opponents of further imposts upon motor vehicles that other property and other persons are also benefited by the development and maintenance of highways, and should pay their part of the cost. We would be the last one to deny that every person, every business, every piece of real property, every social and business activity does benefit and benefit greatly from the development of highway systems. We would be the first one to say that they should pay and pay to assist in the development of highways. But other property and incomes have all other governmental activities to support, and they cannot be bank-

rupted for highways. They must help to pay, but after they have paid for highways all that can, with any equity, be imposed upon them, there remains a large bill which cannot be paid by property or by incomes, but which must be paid by the motor vehicle. There will be paying enough to go around, so that none will feel slighted.

The motor vehicle propagandist then avers that the amount of the bill to be paid by the motor vehicle should be the cost of maintaining highways, and that the motor vehicle should pay no part of the cost of the construction enterprise. How this remarkable conclusion was first arrived at we are unable to determine. Certainly it should be included and enshrined among the most laughable jokes ever sought to be seriously presented to the attention of the American public. "Life" never printed anything half as funny. If carried to its logical conclusion, this masterpiece of economic thought means, of course, that the poorer the roads of a state, the more the vehicle owners of that state should pay; the better the roads, the less they should pay.

Under this wonderful theory, for instance, a state having a 10,000-mile road system to construct might determine to construct it of cement at an average cost of $40,000 per mile. The total cost would be $400,000,000. "This, property should pay." The cost of maintaining this system, when fully built, would be about $3,000,000 per annum. "This the motorist should pay." On the other hand, the state might determine to build the system of gravel and other inferior surfacings at an average cost of $10,000 per mile. The cost of the system would then be $100,000,000. "This property should pay." The cost of maintenance would be about $10,000,000 per annum. "This the motorist should pay." The motorist should pay seven million dollars more per annum for a road system of inferior value and economy than he should pay for a system of roads conceded to give better and more economical service to motor transportation every day in the year. Is it not astounding that men, usually quite sane, seriously claim that this is common sense and correct economics?

Proportions to Motorists and to Other Property.

Is there any measure of the proportion that motorists should pay of the cost of the highway program of a state? No measure has so far been established. The problem has come upon us so suddenly, so much of the reasoning upon it has been wild and unfounded, that American thought has not even begun to crystallize upon any basic measurement of what the motor vehicle should pay.

We have had, of course, the scale of fees in the "proposed uniform vehicle license law" urged as a panacea by the National Automobile Chamber of Commerce. This was proposed several years ago as fair taxation, but died before it was hardly born. As far as we know, no American state ever adopted it and we venture to predict that no American state ever will. Its scale of fees is unscientific, unfair, and far too low; and has value merely as a matter of history.

We claim that there is only one measure of what the motor vehicle owners should pay, viz:

(1) The total sum paid for highway service by the motor vehicle owners of a state should be measured by the benefits the motor vehicle owners of the state receive from the state's program of highway construction and maintenance.

This should be quite obvious. A tax collected should represent services rendered or to be rendered and benefits received or to be received. If great services and benefits are given the owners of motor vehicles in a given state, the charge which that state should make on them can legitimately be much higher than the charges which should be made by a state which gives few benefits and offers little facilities for travel.

If the reader will compare states with the roads of which he is familiar, it is believed that he will assent to the proposition that taxation upon motor vehicles should not be uniform, with all motor vehicles of like kind paying the same tax in every state. He will agree that proper and fair imposts upon motor vehicles will vary with the states, and that the motor vehicle owners of different states should pay and should be willing to pay different sums varying with the highway facilities offered them by their state and county governments. Does the "proposed uniform vehicle license law" meet these conditions? Naturally, it does not.

A Proposed Guide to Judgment.

We are going to venture to give what we believe is a formula by which there can be determined the sum which the motor vehicle owners of a state should annually pay toward its highway program, in payment for benefits they receive from the program. By the highway program of a state, we mean not only the program of the state itself, but also of all units of

government in the state, including its cities.

"The Hirst Formula." The motor vehicle owners of each state should each year pay for their highway service one half of the total amount made available in that year to pay the cost of the state's highway program, after deducting from said amount the total amount made available to pay the cost of the state's highway program in 1904.

Ninteen hundred and four is selected as the basing year because quite dependable figures of highway expenditures in all states are available for that year, and because it quite accurately marks the real beginning of the motor era.

Please again read the formula before condemning it, and note especially that its terms do not include the expenditures made in any year from the proceeds of bond issues, but only the portion of the cost of bonding paid in that year.

Applying this formula to a hypothetical case: In a certain state there was made available in 1904 to pay the cost of all highway work, $10,000,000. There is to be made available $40,000,000 in 1925. The amount the motor vehicle owners should pay in 1925 is one-half the difference, or fifteen million dollars.

The formula means that there would be paid by property and from other sources of governmental incomes:

(a) The total cost of highways which they paid at the end of the era of horse-drawn transportation.

(b) One-half of the additional highway cost imposed upon government by the ownership and use of motor vehicles.

It, of course, means that the owners of motor vehicles would pay:

(a) One-half of the additional highway cost imposed upon government by his ownership of motor vehicles.

This does not seem to us to be unfair to the motorist. If there is any unfairness about it, property other than motor vehicles is probably paying, to say the least, a good full price for the general benefits and advantages incident to highway improvement. Translated into national figures the formula means that, based on total highway expenditures of $200,000,000 in 1914 and of $1,000,000,000 in 1923, the motorist should have paid $400,000,000 in 1923 for use on highways. (Not including the luxury tax and the personal property tax, neither of which is a tax for highways.) This compares with the actual payment of $200,000,000, and means that they should have paid $200,000,000 more than they did pay in 1923, or approximately $14 more per motor vehicle, on the average.

We expect that many will oppose any proposed application of the formula to specific tax problems. We do not claim that it is perfect. In meeting especial conditions in certain states its arithmetical result would have to be modified by the application of common sense. We do claim, however, that it is of value as a guide to judgment. We do claim that it is the first mathematical formula proposed that recognizes the existence of the fundamental facts which should largely determine the relative part of the cost of highway programs to be paid by motor vehicle owners as such, and by other taxpayers as such.

Apropos to opposition to new ideas as to taxation,, Macaulay in his great History of England, in discussing the new highway taxation imposed there in 1685, characterized the public attitude on the new taxes in language just as good and true now as it was when Macaulay wrote it in 1846. We quote him:

"A change was at length effected, but not without much difficulty. For unjust and absurd taxation to which men are accustomed is often borne far more willingly than the most reasonable impost which is new."

Present Systems of Taxation.

We will now briefly summarize and comment upon the various forms of taxation upon motor vehicles.

Valuation Taxes—We believe that there should be a valuation tax upon motor vehicles if there is to be a valuation tax upon any class of property. Of course, if the theory of collecting taxes upon the basis of the valuation of property is wrong, then a valuation tax upon motor vehicles is wrong. Vice versa, if the valuation theory generally held is right, then the collection of a tax based upon the relative .valuation of motor vehicles is right.

The more expensive automobiles are owned for the same reason that the more expensive homes are owned; that is, because the owner believes that they repay him for the added investment and the added running expense in style, comfort, economy and convenience, or in the ability of himself and his family to enjoy life. If he really believes these things are true, he should be willing to pay additional personal property taxation, just as he is willing to pay an additional price to own and operate the more expensive house or motor vehicle. It should be recognized, however, that a valuation tax on

motor vehicles is not a highway tax, but a property tax.

Horse Power Taxes—Many states license motor vehicles upon the basis of horse power. We can think of no physical attribute of a motor vehicle which bears so little relation to the destructiveness of it as does its horse power. Horse power bears little or no relation to the speed, the weight, the value or the use of a motor vehicle. There are at least 32 passenger car models on the American market which have the same or less horse power than the Ford. These 32 models weigh from 1,600 lbs. to 3,500 lbs. and retail at from $500 to $2,500.

Licensing by Weight—This system somewhat classifies the relative destructiveness of various cars as between themselves, and of motor trucks as between themselves and as distinguished from automobiles. Weight has also some relation to value, but only when the vehicles are new. If there is to be a graduated classification of cars for the purpose of licensing them, their weight is the best factor. We believe there should be such a classification.

"Police Power" Licensing—This is a necessity. The cost of the license plates, licensing and of proper motor vehicle policing should be included in the weight license fee and collected at the same time.

Franchise Taxes—Wheel Taxes, etc.—Some states still permit units of government smaller than the state to make charges upon motor vehicles in addition to taxing them as personal property. We believe that such charges should not be allowed to be made but that the full charge for the use of highways should be imposed and collected by the state. Outside of the debatable federal luxury tax now in effect, we believe that the Federal Government should not tax motor vehicles. If everyone around the farm milks the farmer's cows whenever they feel like it and use the milk for all kinds of purposes, the farmer's monthly milk check will be much reduced. Besides, the herd would develop an extremely nervous and irritable disposition.

The amount which the motor vehicle owners should pay for highway service is a thing individual to each state. It should be determined upon by the legislature of the state as a result of the most mature deliberation. Simultaneous increases made by several units of government might, if permitted by law, seriously embarrass the motor vehicle owners and the motor vehicle industry.

The states are the best and should be the only collectors of imposts for highway service made upon motorists. If the division of responsibility for the main highways is such as to make it advisable, there should be distributed to the counties a part of the proceeds. The state and county highway programs in every state should and will consume all that the motorist should fairly pay toward the highway program. The lesser units of government, such as townships, cities, and villages, should be content to see the state and county taxes on property for highways reduced by larger collections from motor vehicles. This will enable them to increase their charges upon property for strictly local purposes, including local highways.

The sum which can fairly be collected from motor vehicle owners has a maximum. If the Federal Government takes a share and the local municipalities take a share, the state and county share will be so much the less. Necessarily the state and counties must make up the deficit by imposing direct taxes upon property or by taking a larger share of income taxation. This simply complicates the situation without changing the final result as to the total taxes paid by the various classes of property.

Motor Fuel Taxes—The motor fuel tax, commonly known as the gas tax, in our opinion, is by far the most scientific impost upon motor vehicles. It meters highway service and the benefits received from the use of highways. It approximates toll gate results without the infirmities of toll gate procedure. The consumption of gasoline varies with the weight, the speed, and the mileage of the motor vehicle. No other factor in the car's domestic economy reflects so closely the benefits received from highway use.

It has been suggested that a tire tax would be just as good as a fuel tax. This might be true if it were not so easy to mail or ship tires, but we fear that if a tire tax were in effect the business of every tire dealer would be with the people of other states. This would be unnecessarily expensive and cumbersome and yield no tax revenue to anyone. On the other hand, gasoline is bought usually from day to day, is best bought in that way, and can thus be handled more cheaply and more safely than if shipped and stored for individual use.

Objection is made that the worse the road, the more fuel consumed, and the more tax paid. This objection can not be met by any argument which we can devise except that as highway construction proceeds, the mileage of road that this objection applies to will become less and less. It is the only practical objection ever urged against the fuel tax, and objections equally valid can be urged against any tax ever in effect or ever proposed.

States can adjust *ad infinitum* license fees fixed by the horsepower, weight or valuation of motor vehicles, or by any combination of these factors. They can probably attain some fairness in the relative fees to be paid by the different kinds of cars and trucks. It can be determined that a Ford should pay so much, a Cadillac so much, a 5-ton truck so much. The relation thus established between them may be fair. But how about the relation between the Ford which travels 2,000 miles and the Ford which travels 15,000 miles—the Cadillac which travels 5,000 miles and the Cadillac which travels 40,000 miles—the 5-ton truck which travels 5,000 miles, and the one which travels 25,000 miles?

If the relative use of highways by various motor vehicles is to be included as a factor in determining the highway tax to be paid by the motorist, then the motor fuel tax must be in effect as one factor in the total imposts. It is the only practical-to-collect impost which marks relative highway use and the relative benefits therefrom.

We believe that many states will find it necessary, at least during the coming heavy construction period, to impose fuel taxes of about 5 cts. per gallon. States which have been extremely backward in highway development, may have to collect as high as 10 cts. per gallon. We believe it will be usual to exempt fuel used other than in highway transport from paying the tax. This will cause some abuses, but there are abuses in every tax system. As soon as motor fuel taxes of quite uniform amount are in effect in every state, practically every objection to the gas tax will have been eliminated, and a method of highway taxation and of highway financing, will have become universal which is as nearly in accord with the equities in the case as human ingenuity can devise.

It is impossible in the compass of a thirty minute discussion of highway financing more than to briefly touch some of the high spots. We have tried briefly to paint a picture of the situation, with no greater hope than that we might start further and much more effective discussion of this major problem of the American people.

It seems absolutely certain that the American people must spend in the next 20 years in the development and maintenance of their highway systems, both rural and urban, a sum approximating twenty billions of dollars. This must inevitably be true, unless the American people not only do not increase, but on the contrary, greatly reduce their present use of highways for transportation. It is equally true that we are facing a financial enterprise and an engineering enterprise far surpassing any previous public enterprise except that involved in the prosecution of the late war.

These things being true, it must be quite obvious that, inasmuch as there appears to be no prospect of a reduction in the standard of American living or in the public expenditures for education, parks, water supply or public health, we must look to and develop new sources of revenue for the payment of a considerable share of the cost of this new highway enterprise. It appears to us that this source of very materially increased public revenue must be the motor vehicle, the thing which largely sets our scale of highway expenditure, the thing which benefits most from the expenditure.

If we are to get very far with this line of thought, we must divorce from our minds the idea that imposts upon motor vehicles for use in building and maintaining highways, are, properly speaking, taxes. They are not taxes. They are just the remainder of the bill due to our ownership of motor vehicles.

One buys a motor vehicle. He pays the price and owns the vehicle. If one is to get any use of it, he must buy fuel to propel it, oil to lubricate it, he must replace worn and broken parts and the tires as they become useless. The costs of these are a legitimate part of the cost of owning and operating a car. We do not consider it robbery when a tire man charges us $20 for a casing, or a gas man $2 for a filling of gas. We regard the owner of the tire shop and of the filling station simply as merchants selling us a commodity which we must have in order to operate our car, so that it may return us dividends, either in money or pleasure, or both.

In exactly the same way we must buy our highway service from the state. Highway service is just as essential and is just as much a part of the legitimate cost of operating a motor vehicle as is anything else that must be bought if we are to operate it with economy and efficiency. A fair charge by the state for this service is not robbery, murder or arson. It is just as clean cut and defensible a business deal as is any other business deal connected with the purchase and operation of a motor vehicle. We pay a fair charge made by government for a commodity—highway service —which, as motor vehicle owners, we must have. Probably we will get out of our payments to the state a greater return than we get out of any so-called private business deal incident to our ownership of a motor vehicle.

We must brush our brains clear of cobwebs, obsessions, prejudices and bunkum, and calmly recognize that when we bought and insisted upon operating fourteen million or more motor vehicles, we bought also a highway expenditure of billions of dollars, just as much a part of the cost of these motor vehicles as are themselves, their tires, their engines, and their supplies. They go together, the motor vehicle and the highway on which it must run. All the costs must be paid.

When the American people come to this only sane viewpoint, it will be possible rapidly to develop the required highway systems. If the motor vehicle is to be soon fully served, if it is to become in our time an instrument of transportation operating, in fact, with something like 100 per cent efficiency 365 days in the year, we must invest billions in highways, and the owners of motor vehicles must pay a fair share of the bill.

In our own state, and elsewhere, we have been sometimes indicted as an enemy to the motor vehicle industry and to the motorist, because we have insisted that the motorist must pay adequately if he wished economictl highway service. Whether or not we are or have been an enemy to the motorist we are unable to prove. We have spent 20 years in this road game but neither our enemies nor our friends can now fairly judge us. Results and highway history will do that in due time.

We do still insist that the motorist must pay—adequately, largely—almost until it hurts. Building a modern American highway system, comprising at least 500,000 miles of road, in two or three decades is not child's play. It is an enterprise of appalling magnitude. It can be done, it will be done, because when the American people need or even wish for anything, they get it. They not only wish for highways, they need them, and they will get them. But they must pay the price—and the principal user of the road, the motorist, can not escape almost scot free from the paying!

The foregoing paper was presented by Mr. Hirst at the recent annual meeting of the Michigan State Good Roads Association.

UNIVERSITY OF MICHIGAN PROVIDES 20,000 SQ. FT. FOR HIGHWAY ENGINEERING AND TRANSPORT IN NEW ENGINEERING BUILDING

By Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Michigan

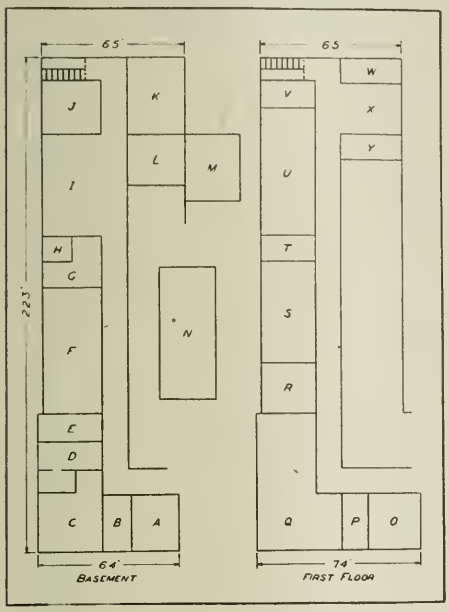
The University of Michigan, in 1919-1920, offered the first course in highway transport to be given in an American educational institution. The number of courses in highway transport now numbers eleven. The rapid development in educational work in highway engineering and highway transport is indicated by six courses in highway engineering being offered in 1918-1919, and 25 courses in highway engineering and highway transport being given in 1923-1924.

The Board of Regents has made provision for the personnel of the new division by establishing a chair of highway engineering and highway transport, and the appointment of an associate professor, an assistant professor, a librarian of the Davis Library of Highway Engineering and Highway Transport, an instructor and three assistants in highway engineering.

All State Highway Testing Done at University

At the time of the organization of the division an ideal arrangement was made with the Michigan State Highway Department, under which all the testing of highway materials for the department would be made in the University laboratory. This cooperative relationship has been efficiently developed in the interests of both the state and the University. The activities of the laboratory embrace un-

dergraduate and graduate courses in highway materials, research work by members of the staff, fellows in highway engineering and candidates for the master's degree; routine examination of materials and the collection of data relative to highway materials, especially deposits of sand, gravel and rock. During the year ending June 30, 1920, the routine work included the testing of 3,641 specimens, while in the year ending June 30, 1923, the number of specimens tested increased to 6,831. The materials tested included Portland cement, sand, gravel and stone aggregates, concrete, ledge rock, paving brick, corrugated metal pipe, clay tile and pipe, reinforcing steel, calcium chloride, tar, asphalt, oils, emulsions, bituminous mixtures and paint.



PLANS OF THE BASEMENT AND FIRST FLOOR OF THE EAST ENGINEERING BUILDING ASSIGNED TO THE DIVISION OF HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT, UNIVERSITY OF MICHIGAN.

KEY TO BASEMENT FLOOR ROOMS.

HIGHWAY LABORATORIES: A. Sample Storage Room. B. Damp Room for Cement and Concrete Specimens. C. Equipment Room. D. Locker, Wash and Shower Room. E. Balance Room. F. Laboratory for Testing Asphalt Cements, Tars, Oils and Bituminous Mixtures. G. Laboratory for Testing Paints and Metals. H. Computing Room. I. Laboratory for Testing Sand, Gravel and Stone Aggregates. J. Cement Testing Laboratory. K. Rock and Brick Testing Laboratory. L. Receiving Room. M. Highway Material Bins, Elevator and Delivery Chute. N. Concrete Testing Laboratory (Located under main entrance lobby.)

KEY TO FIRST FLOOR ROOMS. O. Office of Professor of Highway Engineering and Highway Transport and Seminar Room. P. Stenographer's Office. Q. Davis Library of Highway Engineering and Highway Transport. R. and S. Lecture Rooms for Graduate Courses. T. Office of Assistant Professor of Highway Engineering and Highway Transport. U. Highway Engineering Drafting Room. V. to Y., inclusive. Offices of Associate Professor of Highway Engineering and Staff of Michigan State Highway Laboratory.

Fellowships

Through the generosity of Mr. Roy D. Chapin and the Detroit Edison Company, one fellowship in highway transport and three fellowships in highway engineering have been available each year since 1919-1920. Each fellowship pays the sum of $250 with an allowance of $50 for expenses. Many high grade reports covering important research problems have been prepared by the fellows. The annual competition for these fellowships has been keen, there being 63 contestants in 1922-1923. Graduates of high standing of many institutions have been attracted by these fellowships, the fellows appointed having been graduates of Carnegie Institute of Technology, Colorado State Agricultural College, Cornell University, Dartmouth College, Iowa State College, Kansas State College, McGill University, Michigan Agricultural College, University of Colorado, University of Maine, University of Michigan, University of Missouri, University of West Virginia and West Point. A wide range of professional activities is represented by the men appointed. The 1922-1923 fellows occupy the following positions: Major, Quartermaster Corps, U. S. Army; Resident Engineer, U. S. Bureau of Public Roads; Assistant County Engineer, Texas; instructor in highway engineering, University of West Virginia.

Graduate Short Period Courses

It has been found that graduate semester courses only meet the needs of a small percentage of practicing highway engineers and men engaged in highway transport who desire to obtain advanced instruction, as such courses are not given during periods when it is practicable to secure a leave of absence. Recognizing this condition, the University, in 1919-1920, offered graduate short period courses in highway engineering and highway transport, leading to the degree of Master of Science or Master of Science in Engineering, arranged especially for men engaged in the practice of highway engineering and highway transport. These courses are given in periods of

two weeks each during the months from December to March, inclusive. Each course consists of 30 lectures, or the equivalent thereof, and counts as two hours' credit toward the total of 24 hours required for the Master's degree. Persons of mature age, who do not hold collegiate or technical degrees, but who give evidence of fulfilling the prerequisites of a given course, may register as special students, not candidates for a degree. In the first year, 1919-1920, when such courses were offered at the University of Michigan, the attendance was 29; while in 1922-1923, 110 men attended these courses, the average age of the men being 27 years, ranging from 23 to 56 years. These men came from the U. S. Bureau of Public Roads, state, county and municipal highway departments, contractors' organizations, companies manufacturing motor trucks, highway machinery and materials, universities, and from the field of highway transport. During 1923-1924 18 graduate short period courses will be offered, 10 in the field of highway engineering and 8 in highway transport. These courses will be given by a staff of 8 professors and 10 nonresident lecturers.

Library

Efficient graduate instruction requires exceptional library facilities for research work and collateral reading. The University is fortunate in being the present custodian of the Davis Library of Highway Engineering and Highway Transport, which is the most complete collection of literature on these subjects in existence. In addition to books, reports, specifications, monographs and files of trade publications, all technical periodicals which contain articles relative to highway engineering and highway transport are on file, hence the latest literature on the science and art of these subjects is available. The library is equipped with eleven comprehensive indexes covering its books, reports, specifications, pamphlets, catalogs of materials and machinery, and literature on highway engineering and highway transport.

The development of the activities of the division, the rapid increase in the enrollment of graduate and special mature students, and the expansion of the work of the highway laboratory, influenced the Board of Regents to allot 20,000 sq. ft. of working space for the offices, library, drafting room, graduate lecture rooms, and laboratories of the division of highway engineering and highway transport in the new East Engineering Building, which was opened for use at the beginning of the present collegiate year. The following keys to the plans describe the uses to which the 25 rooms in the basement and on the first floor of the north wing have been assigned.

MODERN CONSTRUCTION OF BRICK PAVEMENTS

By Will P. Blair, Vice-President, National Paving Brick Manufacturers' Association, Engineers' Bldg., Cleveland, Ohio

(Editor's Note: The following paper was presented by Mr. Blair at the annual convention of the American Society for Municipal Improvements at Atlanta, Ga., Nov. 12-16, 1923.)

At the meeting of this society at New Orleans, La., in 1919, we stressed the lack of information as to the conditions upon which we place the wearing surfaces of our streets and roads. We little realized then that our suggestions would be taken as seriously as they subsequently were. Results did follow by the appointment of a committee by the Federal Highway Council, for research of natural influences involved in the subgrade and its relation to road surfacing and traffic.

One of the principal discoveries influenced by the activities of this committee, disclosed the fact that subgrades of most soils throughout the country were subject to contraction and expansion, due to the influence of water. That the forces of expansion in the case of a saturated subgrade was one of extraordinary power, often resulting from its expanding power in the destruction of rigid surfaces, such as cement-filled brick roads, which hitherto had met with the approval of the industry.

As soon as this fact was established, together with information ascertained as to other agencies of destruction, it became perfectly apparent that the construction of brick wearing surfaces would have to be changed, in order to meet with less effect the destructive agencies discovered.

In the meantime the manufacturers of vitrified brick, through their local organization known as the Western Paving Brick Manufacturers' Association, had discovered and utilized a certain refined asphalt, which had the quality of maintaining its place in the brick joints under extreme high temperature, and did not become rigid and fragile under the in-

fluences of low temperature. Experience with this filler, covering a period of about eight years, demonstrated its extraordinary merit.

It was at once recognized, in view of the newly discovered agencies of destruction of rigid pavements, that this method of construction, using this character of asphalt as a filler, afforded sufficient flexibility, so that these forces operating with an upward thrust against the brick surface, had little injurious effect. It was proved by experience that this filler practically protected the edges of the brick equally as well as the cement filler. In the light of this knowledge there was but one thing to do, and that was to strongly recommend to the engineers and the public the use of this particular refined asphalt as a filler for brick pavements, as affording a quality subject to the least possible injury from either traffic or these natural agencies of destruction, and this in brief is the reason for the National Paving Brick Manufacturers' Association strongly recommending this method of construction.

It must be understood that the use of asphalt filler in no way obviates or lessens the necessity of carefully complying with the details of construction, which are so well understood to contribute to the worth and durability of a brick pavement. Nor is the mere use of this filler sufficient to realize the ideal pavement possible, unless the exact and proper refinement of the asphalt is used and it is properly and skillfully applied. Its use must also be accompanied by the skillful installation of other requisites of the improvement as a whole, which constitute and are necessary for the ideal finished pavement.

These requisites are unfortunately often either carelessly dealt with, or ignored altogether, and are bound to result in unsatisfactory pavements. It is essential, of course, that the filler be applied so that the joints shall be completely filled.

Other important details subject to neglect and oversight are:

First—The stabilization of the subgrade, by reducing to a minimum the possible moisture content.

Second—The smoothness of the artificial base.

Third—The uniform compression of the sand bed upon which the brick are placed. Unless compressed, the brick wearing surface will ultimately conform to any unevenness of the base surface. This requirement can only be accomplished by using a hand roller and filling the depressions noticed after each rolling. Three to four repetitions are necessary to accomplish the desired result. Compliance with these details will secure an ideal pavement, and avoid the impairment of the pavement of all possible destruction from contraction and expansion forces.

RESURFACING PAVED STREETS

By D. I. Elder, Currie Engineering Co., Municipal Engineers, Webster City,, Iowa

There is one economic question connected with this subject of resurfacing, which is: "Why is it necessary?" And the immediate reply is: "That the existing surface has failed." Then arises the question: "At just what stage of disintegration is resurfacing required?" And the proper answer to this question requires the exercise of considerable business judgment. It is not possible to set a rule that will hold in all cases, but each project requires consideration on the basis of the factors involved.

When to Resurface

In the first place, on account of the expense involved, it is advisable to put off the day of resurfacing as long as possible, if the pavement can be maintained in good condition by timely repairs. Not long ago, in one of the engineering periodicals, the experience of an eastern city was given, in which the subject of maintenance and resurfacing was taken up from the standpoint of management and accountancy. Records were kept for a long period of years showing the initial cost of each paving job and the annual repair bills for each. In that city it had become the rule that resurfacing was warranted as soon as the annual repair cost had crossed a certain line, the amount representing a tax sufficient to pay for resurfacing in the course of a few years.

Good Pavement Invites Traffic

A pavement has been defined as a base that is sufficient to transmit the load of traffic to the soil, and a surface that will resist abrasion. When, therefore, the pavement fails, it is necessary first of all to find out why, and to make the restored surface adequate for the needs as they exist and for those that can be forecast. In this connection I must say that a common experience in considering the plans for resurfacing an old street is as

follows: The argument is advanced that the cost should be kept as low as possible to permit the improvement being considered at all, and for that reason the type of surface and construction details should be specified with regard to rather light traffic, the statement being frequently made: "These streets do not have what you might call heavy traffic." The reply it: "That the traffic the restored surface is going to receive cannot be predicted on the basis of that now being routed over this street, for the reason that it is too rough to permit much traffic. As soon as a smooth surface is laid, then the chances are the street will be used more. A good street is an invitation to traffic." If a pavement has failed under one given set of conditions, it is well to assume that in future conditions will be even more severe.

Causes of Pavement Failures

At this point it is well to inquire into some of the general causes for the failure of some of the pavements that will require resurfacing, and in many cases the pavement is of an obsolete type. I have in mind particularly some of the old brick pavements that were laid without a concrete foundation, on a generous sand cushion and with a sand filler. Now, while such a pavement might have been all right for horse-drawn traffic for a time, soil shifting, trenching and uneven settlement of the sand cushion have left the surface in humps and depressions. In some cases the brick used were not as hard as are required for present practice, and the edges are badly chipped. Traffic over such streets is usually very light at the present time if any other routing can be found, and where this is the only practical route for traffic, the speed is reduced.

Construction Faults

Formerly, many thought that a 4 in. concrete base was sufficiently thick, and that the mortar could be somewhat leaner than that in use now. Also, it used to be the custom in laying a concrete base, when stopping work at night, to make a joint as follows: The last concrete that was poured was flattened out to a thin edge; then in the morning when starting work, the fresh concrete was poured on top of this thin edge poured the night before, and the surface carried from that point on. This made a sort of sliding joint, and it was thought necessary to provide for expansion and bridge the joint. But now some of these joints are found badly shattered or lapped, appearing in the surface of the street as a hump. Again, in cases of lean concrete it is often found that where cracks are formed by contraction, the concrete at the edges of the cracks is badly shattered, resulting from pressure when they have expanded again.

Inspection

Another general cause for rapid deterioration in pavements can be brought under the head of specifications, inspection and construction. Many pavements have failed because the specifications were drawn so as to permit the use of materials, mixtures and construction practices that were not suitable for the conditions to be met. Inspection includes the preliminary examination of materials, and the control of the mixing process in preparing them for the street. Sometimes inspection has been what we may term visual; for instance, the suitability of gravel might be judged by examining a handful taken at random from a pile. Construction engineering includes the supervision of the job while work is in progress; and some failures are to be traced to the fact that, where a certain depth of concrete was specified, something less has been secured, and other details of workmanship and finish have not been carried out as the specifications have contemplated.

Cheap Pavements

One further possible source of trouble is found in the following condition: Suppose an important street from a traffic standpoint to be bordered by vacant property that has a very low value for purposes of special assessment; such, for instance, as the street leading from the center of town to the team tracks at the railroad freight house at the outskirts, and that connects with the primary highway from that point. The most economical pavement for such a locality might be too expensive a type for the assessable property to pay for, and the needed improvement has to be built of a less expensive type with the expectation of later resurfacing.

Rebuild to Suit Traffic

Now this discussion of the causes for failure of a pavement leads up to the proposition that when the surface is finally restored, the pavement should be a permanent piece of construction designed to meet modern traffic. Before the plans for any resurfacing project can be decided, it is necessary to make a thorough

investigation of the existing pavement, and of the traffic conditions it will have to meet, and then decide what is to be done. Without such an investigation and plans made after mature consideration, the taxpayers may be disappointed in the short life of the restored surface.

Foundation Strength

Apparently the abrasive action of traffic is much less a factor in the destruction of the surface than was formerly supposed; and I believe it is now being recognized that the strength of the foundation is the biggest factor in the modern pavement. Therefore, in making plans for the restoration of the surface, the base or foundation is the first point requiring consideration. For, if additional strength is needed in the base and is not provided, difficulty is sure to develop later on.

Curb and Crown

Of course the height of the curb and the crown of the street will, in some situations, limit the plans for treatment of the surface. But consider the case of a pavement which was not originally designed to meet present loads, consisting of only 4 ins. of a comparatively lean concrete. Investigation may reveal such a shattered condition of the base that renewal of a flexible surface would be only a temporary improvement. It has been suggested that, in such a case, the addition of 3 or 4 ins. of rich concrete, finished for the new surface, be applied.

Brick Salvage

The treatment of old brick pavements requires special consideration in each instance. There is a possibility for some salvage in the brick if, upon examination and test, it is found that the brick are suitable. For if an uneven brick surface is due to shifting of a sand cushion and to broken edges, they may be taken up and laid with the worn edges down, upon a concrete base, with a sand cushion stiffened with a little cement, and with a bituminous filler. On the other hand, it may prove more economical to cover the old brick with an asphaltic type of surface, using an asphaltic concrete binder to fill up the depressions in the old surface and bring it up to the proper grade and crown.

Old Concrete Pavement

An old concrete pavement presents a variety of possibilities, except that the depth of the curb is a limiting factor. After repairing the broken places, and if the base is sufficient, an asphalt or a brick surface may be applied, or even an additional thickness of concrete.

Asphalt Pavements

Asphalt pavements, on account of the elasticity of the surface and its plastic nature, present another special problem. The usual condition of an asphalt street that has failed is that the surface has shoved under traffic, and has formed waves of such height as to give the impression that the base is broken and has turned up on edge. Usually, examination shows the base to be in good condition, but the asphaltic mixture so far disintegrated that water and frost are able to continue destructive action. Often the surface has broken out in places, leaving the base bare. It is often recommended that a thin layer of surface mixture be applied to a wrinkled surface, but this can be considered only a palliative, if the cause for pushing was the instability of the mixture used.

Topeka Mix

For many years a popular type of asphalt pavement has been the Topeka mixture, or asphaltic concrete, whose characteristic is that it is composed of crushed stone finer than ½ in., mixed with fine sand and asphaltic cement. After the wear of a little traffic, the coarse stones appear in the surface as a mosaic. The popularity of this type of mixture is that it is somewhat cheaper than others, while presenting a very smooth riding surface, and large yardages are in use and still being built. But it has been authoritatively stated that this type is tending to shove under traffic, unless it is laid on a binder. In bituminous pavements of the coarse aggregate type, one of the agents of destruction is water which penetrates along the edges of the coarse stones. And if the stones be of a porous nature, as limestone, frost completes disintegration. Some pavements of this type show a surface pitted with holes where stones had once lain. I believe it is the recognized principle of those now interested in the asphaltic concretes that the preservation of the surface is to keep it waterproof by the application of a hot sand and asphalt mixture, rolled on to form the wearing surface.

Asphalt Mixtures

In dealing with an asphalt pavement that has failed, the first necessity is to examine the existing mixture to determine its condition and grading. This is especially important. The art of asphalt

paving was developed in earlier years by a process of trial and error, good and bad pavements resulting. Later research conducted upon these older pavements has revealed the standards by which it is necessary to govern the mixtures and the construction details in order to build an asphalt pavement whose wearing qualities can be predicted with any certainty. An examination of the mixture from an old asphalt pavement that has failed usually reveals the fact that some of the standards have been violated. Exceptions are to be found in the case of city streets where the asphalt borders car tracks, and the traffic is so continuous that the normal wear of years occurs in a compaatively short period. The other extreme is the case of a street that receives almost no traffic, and the asphalt cracks because there has been too little traffic to keep it kneaded into a smooth surface.

In case examination shows that the mixture is faulty, there is only one remedy, which is to remove it and replace it with a proper mixture, properly constructed. On the other hand, especially in the case of pavements of the coarse aggregate type, if it is found that the composition is inherently stable, and that the surface is suffering only from the attack of weather, it may be restored by the application of an inch or more of a hot sand and asphalt mixture; in other words, a sheet asphalt mixture, that conforms to modern standards.

In many localities the resurfacing issue is becoming acute, and it is here desired to point out that in the past few years our paving standards have changed to meet conditions that were not dreamed of in the earlier years. So many possibilities for renewal are apparent to one who gives the matter thought that there is ample room for the exercise of good business judgment. Good engineering consists not only in constructing durable improvements, but in constructing durable improvements with the utmost economy consistent with good practice.

The foregoing paper by Mr. Elder was presented at the recent annual meeting of the League of Iowa Municipalities.

GRAVEL ROAD MAINTENANCE IN MICHIGAN

By B. C. Tiney, Chief Inspecting Engineer, Michigan State Highway Department, Lansing, Michigan

We have, in the trunk line and state rewarded road systems of Michigan about 12,250 miles of improved roads, of which about 9,250 miles, or 75 per cent, are gravel surfaced. The general distribution of gravel throughout the state, together with the comparative simplicity of construction and low first cost of this type account for the large percentage of gravel surfaces.

Since the advent of the motor car in large numbers, the maintenance of these gravel roads has become one of the most serious problems confronting highway officials of Michigan. The increase of the legal speed limit to 35 miles per hour has added further to the difficulty and cost of this maintenance.

The moisture content of the gravel is an important factor in the work of keeping the surface smooth, as shown by the ready formation of ruts and holes after a heavy rain and the tendency of the surface to ravel in very dry weather. The dry weather condition is probably the more serious, as it is usually coincident with the peak load of tourist traffic, and the patrol work is very ineffective without a certain degree of moisture in the surface.

Graders and Drags

Several types of graders and drags are used in patrol maintenance. A survey of this equipment in the state shows that 53 per cent of the counties are using horse-drawn machines entirely, while the others have either wholly or partially adopted motor equipment. The larger counties prefer the motor equipment because of the greater efficiency in covering a large mileage. The grader or drag pulled by a tractor, or the tractor and blade in one unit are used, but the most popular equipment, perhaps, is the two or three ton motor truck with a spring scraper attached underneath. This is very satisfactory if operated at a speed of not to exceed 8 or 10 miles an hour, but does less effective work at higher speeds. The spring scraper is used only for floating loose material, and should be supplemented by a heavy grader and tractor after rains, to plane the surface and eliminate ruts and holes.

Resurfacing With New Gravel

The gravel surface is also kept smooth by an occasional resurfacing with new gravel. A satisfactory material for this purpose is that ranging in size from ¾ in. down, and having about 75 per cent retained on a ⅛-in. screen. A partially crushed gravel has been found desirable. The application, if limited in depth to

about an inch, will not be objectionable to traffic, and this represents about the minimum amount of gravel that should be returned to the road each year to replace that which is worn away. The road should have a covering of about ½ in. of loose material at all times, for efficient floating.

Formation of Chatter-Bumps

One of the greatest enemies to smoothness in a gravel road is the oversized stone. Stone over 1 in. in size should be rigidly barred from the top course during construction, and certainly should not be permitted in any resurfacing material. The tendency of the large stone to work to the top by frost action is well known. Whenever a car strikes an obstruction such as a projecting stone, the springs are at first depressed and then expanded, lifting the weight of the car from the road. When the springs return to their original position the weight of the car strikes the road surface, causing small depressions. The spinning drive wheels also kick back some gravel and increase the tendency to form holes. This process continues and the holes grow rapidly in size and number until we have a whole series of corrugations or "chatter-bumps." Wet weather and flat grades are especially favorable to their formation, as water collects in the holes and is thrown out by the traffic, carrying fine binder material with it.

Dust Control

Perhaps the most disagreeable feature of the gravel road is dust. The discomfort not only to the motorist but to the resident along the road, together with the danger added to highway traffic by dust, make its elimination or reduction a matter of prime importance to highway officials.

On secondary roads having a traffic up to about 300 vehicles per day, the dust is not extremely objectionable. Our traffic census shows that of the 3,245 miles of trunk-line gravel roads, we have about 20 per cent, or 650 miles, carrying a traffic of less than 300. About 35 per cent, or 1,135 miles, carry a traffic between 300 and 600, while about 45 per cent, or 1,460 miles, carry over 600. A census of the county systems would probably show larger percentages in the lower traffic divisions.

Those gravel roads having a daily traffic of more than 300 vehicles demand some form of dust elimination or reduction if they are to render 100 per cent service to the public. Two forms of dust palliative have been used in Michigan, namely calcium chloride and light asphaltic oil. These two materials function in a similar manner. Their proper use does not permit of application in sufficient quantities to entirely eliminate the dust, as this results in the formation of a surface crust which soon breaks up into holes and necessitates scarifying. If applied in smaller quantities at more frequent intervals, however, the dust may be reduced to a point where it is not objectionable and still leave enough loose gravel on the surface to be floated back and forth in patrol work. A uniform covering of ½ to 1 in. of loose material over the road surface before applying the dust layer is very desirable. Sections not having this cover are observed to glaze over and then break up into holes within a few weeks.

Calcium Chloride

Between four and five thousand tons of calcium chloride are used annually in this state. The best practice is to apply from ¾ to 1 lb. per sq. yd. for the first application and ¾ lb. per sq. yd. for the second application, or perhaps make a second and third application of ½ lb. each, depending upon local conditions. A total of 2 lbs. per sq. yd. is usually ample to lay the dust for a period of 3 to 3½ months. The cost of this work ranges from $225 to $300 per mile for a season. In some sections of the state, traffic and local conditions are such that one application of about 1¼ lbs. per sq. yd., placed on an 8-ft. strip in the middle of the road, renders it fairly dustless for the season. The chloride on this 8-ft. strip is worked to the edges of the road by traffic and patrol work, and under this system the cost has been reduced to about $125 per mile.

Light Asphaltic Oil

Light asphaltic oil has not been used to any great extent in Michigan as a dust layer, it having been tried experimentally during the last three years. About 44 miles of road were treated in 1923. The oil used conformed to the State Highway Department's specifications for this material, and was applied by pressure distributor, without heating. The first application consists of 1-6 to 1-5 gal. per sq. yd. and renders the road fairly dustless for a period of about six weeks, after which a second application of about ⅛ gal. per sq. yd. is necessary. The re-

lation between the quantity of oil applied and the amount of loose gravel on the road is important. The above quantities would apply to a surface having a uniform covering of about 1 in. of loose material.

The most common error in oil treatment has been the use of too much oil in the second application, resulting in matting of the surface and subsequent roughness. The cost of two-application work in counties doing a rather small mileage has been about $400 per mile. One county which is particularly well equipped for doing this type of work, made one application on 41 miles of road this year at an average cost of $132 per mile. This was applied to a width of 12 ft.

Success With Dust Layers

Summarizing our experience with dust layers, we believe that the things most essential to their successful use are:

First—Proper control of the material by specifications.

Second—The presence of a uniform covering of loose gravel on the road before treatment.

Third — Application in sufficiently small quantities to avoid solidifying the surface.

We have some 1,400 miles of trunk-line gravel roads carrying a traffic of more than 600 vehicles per day, and ranging in some cases to as high as 3,000 per day. There are, in addition, some county gravel roads having a daily traffic in excess of 600. The ultimate solution in case of the heavy traffic gravel road is, of course, to reconstruct with a permanent type of pavement. The time required to finance and build this large mileage of pavement will necessitate the maintenance of some heavily traveled gravel roads for a number of years.

Bituminous Surface Treatment on Gravel

A partial solution of this maintenance problem may be found in the bituminous surface treatment on gravel, in the same manner as applied to macadam. We now have about 53 miles of this type of maintenance in the state. It cannot be successfully used on all kinds of gravel, and should be attempted mainly on those roads containing a high percentage of stone, thoroughly compacted. The nearer this approaches a macadam structure the better will be the results of treatment. A few of these roads received an initial treatment several years ago and have since been given lighter treatments. Twenty-six miles were given a first treatment in 1923.

The principles governing the surface treatment of gravel roads conform very closely to the established practice in surface treatment of water-bound macadam. In preparing the surface sufficient blade work should be done to eliminate ruts and holes. This work may be continued to advantage up to within two or three days of time of treatment, provided the gravel contains enough moisture to shape well. The surface is then thoroughly swept, removing all loose material and exposing the large stone. Particular attention should be given to cleaning the edges, and traffic should not be permitted to use the road between the time of sweeping and treating.

Bituminous material is applied first as a prime coat at the rate of about 2-10 of a gal. per sq. yd., and allowed to penetrate for 24 hours or more. The second application is made in the amount of about 3-10 of a gal. per sq. yd., followed by a cover of stone or slag chips or pea gravel.

The hand maintenance which must follow this treatment is best conducted by mixing some of the same bituminous material used in the treatment with coarse sand. This is usually done with a small concrete mixer at a central location and the mixture is stocked in small piles along the road. Small surface breaks are easily repaired with this mixture. We have found that on gravel there is more tendency toward surface peeling, the first year, than there is on macadam. One man, equipped with a wheelbarrow and shovel can, under normal conditions, keep about 10 miles of road in good condition. This patrol work should be followed up consistently.

Cost of Maintenance

The cost of maintenance of gravel surfaces having a daily traffic of more than 600, by the system of patrol graders, necessary resurfacing and dust palliatives, ranges upward from $600 per mile per year. A study of costs in a number of representative counties of the state would indicate that the relation between cost and traffic is, roughly, that the annual cost of this type of maintenance in dollars per mile equals the average daily traffic. That is, a daily traffic of 800 to 1,000 vehicles means an approximate annual maintenance cost of $800 to $1,000 per mile.

The cost of a bituminous surface treatment is about $1,000 per mile for the first treatment and $750 per mile for subsequent lighter treatments. We have reason to believe that not more than three treatments will be required in a period of four years, which would bring the average annual cost of treatment down to about $625 per mile. In addition to the surface treatment we have the patrol or hand-patching work, which will cost about $250 per mile, making a total annual cost of $875 per mile. This cost compares favorably with that of maintenance by the system of patrol graders, resurfacing and dust palliatives, for roads of 800 to 1,000 traffic. The bituminous treatment would probably be the cheaper method for roads of higher traffic.

Extreme frost action may necessitate scarifying and retreating some sections, but very little of this has been required on treatments of several years' standing, in this state. One or two failures of surface treatments on gravel have been partly due to lack of proper attention to details in placing the treatment, but largely due to the absence of patrol or patchwork, and these failures only serve to emphasize the importance of this latter phase of the work.

Aside from the consideration of cost, the bituminous surface treatment converts the gravel road into a higher type. It provides absolute instead of partial elimination of dust, and produces a good driving surface, free from loose gravel. Treatments placed this year have been highly commended by the driving public and the owners of abutting property. Referring to the surface-treated sections placed this year on Trunk Line 65, north of Ann Arbor, the Washtenaw County Road Commission, in its annual report, states that "no money ever spent for road maintenance in this county has given as much satisfaction to users of the road, as well as residents along the road."

The department feels that this type of maintenance, if properly handled, will provide a desirable intermediate step between the gravel surface and the pavement.

The foregoing paper by Mr. Tiney was presented at the recent convention of the Michigan State Good Roads Association.

CONTROL OF STREAM POLLUTION

By Charles F. Dalton, M. D., Secretary, Vermont Department of Public Health.

(Editor's Note: Following is the text of the report of the Committee on Sanitary Engineering of the Conference of State and Provincial Health Authorities, held at Washington, D. C., May, 1923.)

Streams since time immemorial have been considered the logical place for the disposal of all kinds of waste and refuse, and every community situated on a stream considers it its inalienable right so to use it, regardless of the effect it may have on a neighboring community. This practice has and still is so general and has been so persisted in that in many instances it has become a serious menace to public water supplies.

The importance of the control of stream pollution was very forcefully brought out in a Progress Report of Committe on Industrial Wastes in Relation to Water Supply, of the American Water Works Association Standardization Council, published in May, 1922.

This committee conducted studies of the effect of discharge of industrial wastes into streams on water supplies and tabulated the results by states. This shows that more than half of the states have suffered more or less damage to public water supplies on account of pollution by industrial wastes. To quote from this report, "with the growth of industries the injurious effects of industrial wastes upon water supplies and water purification processes are becoming more and more important. Serious troubles from this source have already been experienced in numerous places and water supplies are being menaced to a greater and greater extent by the discharge of industrial wastes into existing or potential sources of water supply. The subject of industrial wastes in relation to water supply is, therefore, very timely, and of vital importance."

Public Water Supply of Nation Threatened

It is the opinion of your committee that the above quoted statement is beyond refutation. Anyone at all familiar with the conditions cannot fail to see the grave danger threatening the public water supply of the nation, nor to recognize the necessity of proper control of disposal of wastes, not only from the industries, but of a domestic nature, so that the water supplies may be safeguarded. The above mentioned report shows an average of ten supplies each, in the states from which replies were received, have suffered from

this trouble, one state alone reporting 138 supplies affected. It states that "the extent of the pollution may be so great as to interfere with the ordinary water purification processes or actually to render such process incapable of producing a satisfactory water." It is not difficult to foresee what this means, if allowed to continue uncontrolled. Already cities have been put to great expense, to seek new sources of supply, when proper control of waste disposal would have been the wiser from an economic point of view. However, in the absence of proper authority or control this method has been rendered impossible.

Beet sugar refineries of Ohio have seriously affected the water supplies of that state, the State Board of Health reporting that "The vegetable organic matter increased the color and bacterial content of the water, and interfered with the filtration and chlorination processes. The ordinary purification facilities, including storage, aeration, coagulation, filtration and chlorination, were only partially effective in remedying the objectionable effects."

Pollution by Mine Drainage Serious in Some States

Pennsylvania and West Virginia have reported serious trouble from discharge of mine drainage water into public water supplies. Engineering and Contracting for Feb. 14, 1923, contained an article by Mr. J. W. Ledoux, Consulting Sanitary Engineer, entitled "Water Supply Contamination by Mine Drainage." It is a discussion of the situation in Pennsylvania, and brings out the seriousness of conditions from the water supply point of view. In some sections of the state the problem has already reached the stage where careful study is necessary to decide whether the sacrifice of the water supply or of the coal is best from an economic standpoint. It has been estimated by Mr. C. A. Emerson, formerly chief sanitary engineer with the Pennsylvania State Department of Health, that the cost to the State, of this pollution by mine drainage, is more than eight million dollars annually. In some instances it has been necessary to abandon a water supply and seek another source, on account of the acidity produced by mine wastes. The cost of chemicals for treating the water has been prohibitive, necessitating the procurement of another source of supply.

Phenol Wastes Difficult to Control

Another source of trouble, and one which is not dependent on natural, geological deposits to delimit its field, is waste from gas and coke plants and from wood alcohol plants. Milwaukee has suffered badly from tastes and odors in its water supply produced by wastes of this character. They are responsible for the so-called "creosote" odors and tastes in water, which are intensified by chlorine disinfection. As it is a generally recognized fact that all surface waters should be disinfected before use as a domestic supply, and as these "creosote" odors are noticeable even in very great dilution, one part of waste to ten million parts of water, the menace to water supplies from this source is apparent. At Milwaukee it was found that the tastes were produced by one part of waste in 500,000,000 parts of chlorinated water. It is evident that under such circumstances, natural dilution, especially in streams, cannot be relied upon to prevent trouble. According to the report of the Committee on Industrial Wastes in Relation to Water Supply, above referred to, no satisfactory method of water purification has been found, to eliminate the tastes and odors due to the phenol wastes. It has been found necessary to begin corrective measures on the waste before discharge into a water supply. At Milwaukee experiments with the activated sludge process of sewage disposal indicate that this will be able to protect the water supply even when the phenol carrying wastes in the sewage are very considerably increased.

Some sections of the country are affected by the salt water and crude oil from operation of oil wells. The discharge of salt water from oil wells causes the majority of trouble from this source. It not only pollutes the surface waters but in some cases, notably in Oklahoma, underground waters have been affected through adandoned wells which were ineffectively plugged. Oil refinery wastes also cause trouble. It is reported by Mr. F. M. Veatch that the Verdigris River has been so badly polluted by these wastes that at times it is impossible to wash dishes in the city water of several cities without leaving a taste on the dishes.

Examples of Stream Pollution Numerous

We have mentioned some of the most glaring examples of stream pollution by industrial wastes. It does not appear to your committee to be necessary to burden you with a detailed reference to result of contamination of water supplies by each individual type of industrial waste. The literature is replete with such illus-

trations, in fact, the bibliography on the subject would be nearly as long as this report itself. The problem has received recognition by communities, State Health Boards and by the Federal Health Service, and thousands of dollars have been spent in making investigations for the purpose of correcting existing evils of this character, or to find some means by which it can be prevented in other places. Many other types of industrial wastes may be as obnoxious as those mentioned above, for example, chemical manufacturing wastes, corn products wastes, dye wastes, leatherboard and strawboard wastes, wastes from munition plants, pulp and paper mill wastes, tannery wastes, textile industry wastes, both from woolen and cotton mills and many others are on record as having seriously affected the quality of existing water supplies, or rendered potential sources unfit for use. The States of Connecticut and New Jersey have made numerous investigations of streams, and practically every stream in those states has been found to be more or less seriously affected by wastes of one sort or another.

The States of Pennsylvania, Ohio, Minnesota, Wisconsin and others have found very similar conditions, and it is the belief of your committee that most of the states would find that many of their water supplies are facing a grave danger from this source if thorough investigations were made. In view of the fact that practically every kind of industrial waste may be considered as a potential source of pollution of water supplies, the importance of early recognition of this problem cannot be over-estimated.

Prevention of Pollution Most Important

It is not our intention to outline methods of correction of existing evils of this character, for two reasons. First, because no remedy has been found to correct the water after the pollution has occurred, and second, because each individual case is a problem by itself which can best be corrected after thorough study of conditions. Our object in discussing this subject is rather to bring to the health authorities a realization of the seriousness of the problem, in the hope that it may direct the attention of some of the less afflicted to the dangers ahead, so they may take steps to prevent a wholesale destruction of water supplies in their state. Boards of health are charged with the duty of preventing the preventable diseases, and of securing the people against unnecessary exposure to disease. It is also their duty to prevent conditions which cause disease. It is a well recognized fact that a good water supply is one of the most potent factors in maintaining good health. The work of preservation of the sanitary and esthetic quality of a public water supply is therefore, a logical and proper part of the duties of such health boards. The esthetic consideration is included because if a water, although safe from a sanitary point of view, is objectionable on account of tastes or odors or for some other physical characteristic, it may cause consumers to turn to other sources, which may not be safe, thus creating a strictly public health problem.

It has been learned that in most of the states where serious industrial waste problems have occurred, the state boards of health have some control, but in only five has ample authority been given the health authorities fully to control conditions. Practically all the states report that enforcement of the laws is materially hampered for lack of sufficient appropriations for field and laboratory personnel.

Three Lines of Procedure in Correcting Conditions

In general there are three lines of procedure for correcting unsatisfactory conditions due to pollution by industrial wastes, namely:

1. Purification of the water.
2. Treatment of the industrial waste before discharge.
3. Preventing the discharge of the wastes into the water supply.

The boards of health should have sufficient authority to compel the employment of one of these, but before ordering any particular community or industry to carry out any measures, a careful study should be made to determine which is the best remedy, giving due consideration to established industries.

Legal Authority and Adequate Appropriations Necessary

It is believed by your committee that the control of stream pollution for the protection of existing and potential water supplies is one of the most important problems with which the Sanitary Engineering Divisions of the State Boards of Health have to deal, and the health boards of our states should see to it that every effort is made to secure the enactment of laws to place in their hands the necessary authority to enable them effectively to control the situation, and to secure adequate appropriations to provide the necessary field and laboratory workers to carry out the investigations. A change of policy in some states will be

necessary, in order to give the public the protection to which it is entitled.

This is one of the many problems confronting the sanitary engineer in the state health departments, but in view of the trend toward destruction of all surface sources of water supply, it is believed to be of sufficient importance to take a prominent place in our report. It is hoped that this presentation of this subject will stimulate discussion which will be of help to those states which are not yet seriously affected, to the end that they may institute preventive measures and thus avoid the difficult and expensive corrective measures to which some of our states are already put.

CONSTRUCTION OF OUTDOOR SWIMMING POOL AT CEDAR RAPIDS, IOWA

By Howard R. Green, Consulting Engineer, 208 Bever Bldg., Cedar Rapids, Iowa

The factors governing the design of a large, outdoor swimming pool built this year on the grounds of the Country Club at Cedar Rapids, Iowa, were as follows: To fit the finished pool into the rugged topography of the location with natural effect; to build a pool sufficiently large to accomodate some 350 members and their families, providing ample separate areas for the use of swimmers of varying ability with safety and convenience, and to keep the expenditure for construction under $10,000.

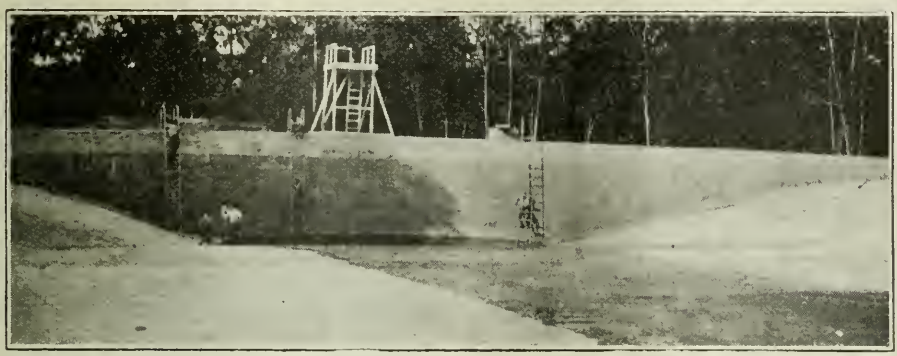
The location reserved for the pool was a natural ravine, cutting through a 100-ft. bluff along Indian Creek. The channel of the ravine sloped toward Indian Creek at the rate of about 14 ft. in 100. The sides of the ravine rose from a rounding bottom at the rate of about 20 ft. in 100. The pool as built in this ravine is pear shaped and measures 138 ft. along the axis of the ravine and 120 ft. in maximum width. The lower end of the ravine was dammed by the construction of a circular wall having a radius of 50 ft. for most of its length. The total length of the wall is 150 ft., the top being 1 ft. above water level and the central 48 ft. having a height from top of wall to top of footing of 13.5 ft., giving a maximum water depth of 12 ft. The footing from the ends of this central maximum section rises at a uniform grade until, at the extreme ends, the height of the wall is 1.5 ft. from top of footing to top of wall. The length of the water line around the edge of the pool is approximately 400 ft. and with the exception of the walled portion, the floor slab gradually rises to form a beach, the maximum slope being 1 to 2½.

The shallow end of the pool has an area of 2,600 sq. ft. varying in depth from 1 ft. to 2.7 ft. This area is separated by a rope and floats from the rest of the pool and is reserved for the use of children. The next area of 2,600 sq. ft., ranging from 2.7 ft. to 5 ft. in depth, is used by novices and affords a straightaway averaging 25 ft. by 90 ft. of swimming depth. A deeper swimming area ranging from 5 ft. to 8 ft. in depth, having an area of 3,500 sq. ft. affords a space of approximately 30x90 ft. for competitive swimming events. The remainder of the pool, which is the only portion bounded by the wall, provides 2,600 sq. ft. for diving, the depth ranging from 6 ft. to 12 ft. and there being 107 ft. of wall with 6 ft. or more water depth. Two spring-boards and a diving tower are symmetrically located at the deep end of the pool, all inside the 12-ft. depth line.

Around the outside edge of the beached portion of the pool, a gutter varying in depth from 6 to 10 ins. acts as a scum gutter for the pool and an intercepter for storm water flowing from the terraces

VIEW OF LARGE, OUTDOOR SWIMMING POOL OF CEDAR RAPIDS, IOWA COUNTRY CLUB

around the beach. Four catch basins carry off the water from this gutter through 8-in. vitrified tile lines and four ¾-in. galvanized pipe lines constantly play water into the gutter to furnish a foot wash for the bathers entering the pool. The entrance is at the shallow end and is approached by concrete stairs coming down the terrace. Sub-drainage is afforded by one line of 8-in. vitrified sewer pipe encircling the entire location and a gridiron of 4 and 6-in. tile laid underneath the floor. These tile lines are laid in trenches 3 ft. deep in the clay subsoil, No. 2 sewer pipe being used with no joint filler and the trenches being back-filled with coarse river sand. The sub-drain lines and gutter catch basins are all brought to one common outlet which affords an opportunity to gauge the amount of leakage and in case of serious break in the floor, the pool could be drained before any great damage was done. Fresh water flows into the pool at the shallow end through a 4-in. city water main, which is valved and metered in a control manhole concealed in the terrace. Gravity drainage is provided at the deep end through a 12-in. cast iron main running about 40 ft. beyond the limit of the pool from the end of which the water falls some 50 ft. to Indian Creek. From this 12-in. drain line between the valve and the wall, a 6-in. line runs to a pump and a chlorinator house, where a motor-driven centrifugal pump with a capacity of 450 gals. per minute forces the water through a 4-in. cast iron line around to the shallow end of the pool, where it tees into the fresh water supply line. In the pump house is located a liquid chlorinating outfit treating the water immediately after leaving the pump.



VIEW OF ONE SECTION OF NEW SWIMMING POOL AT CEDAR RAPIDS, IOWA

Construction

As soon as the site was cleared of trees, the excavation for the wall footings was made by hand. It was deemed advisable to place the concrete of the wall in one continuous operation. The footing varied from 8 ft. by 16 ins. to 5 ft. by 12 ins. At the junction of the footing and the 12-in. wall, the footing rises at 45 deg. for 1½ ft. on both sides of the wall. In order to effect continuous operation, therefore, concrete supports 3x1 ft. in area and varying from 3 ft. to 2 ft. 6 ins. in height were constructed along the line of the wall at about 10-ft. centers. On these supports the wall forms were constructed and from the plate resting on these concrete supports, the forms for the 45 deg. bevels are hung. In order to bond these pedestals to the wall, steel dowels were used and beveled 2x4's were set in the sides and removed before the final placing of concrete. The wall contained 100 cu. yds. of concrete, which was placed in one 12-hour run.

Immediately after stripping the forms, the inside face of the wall was smoothed with carborundum bricks and the excavation for the main portion of the pool was started. The equipment used was two Maney wheeled scrapers drawn by a caterpillar tractor. The material was deposited in thin layers behind the wall and compacted by subsequent trips of the tractor and wheelers. Operations continued until the fill had reached the top of the wall to a width of 10 ft., after which the fill was built by dumping over the edge. When the sub-grade under the floor was practically finished, the sub-drain lines were laid and back-filled with sand.

In order to get a water-tight connec-

tion between the floor slab and wall, a 1x2-in. cypress strip was inserted in the vertical face of the concrete wall footing, 3 ins. below the top of the footing. The excavation was notched against the face of the footing so that the concrete floor slab extended 6 ins. below this strip. Another strip was laid against the beveled footing at grade of the top of the floor, the floor slab being 6 ins. in thickness on top of the horizontal footing slab. Concrete was mixed at the shallow end of the pool and hauled to location in Ford dump trucks, hauling approximately 12 cu. ft. The surface was given a wood float finish in order that it might not be slippery under water. The wood strip at the wall connection was removed and the joint filled with asphalt. Three construction joints between day's work were built by a cypress strip embedded in the body of the concrete with an asphalt-filled notch immediately above it. One-half-inch square steel rods at 3-ft. centers both ways were used to reinforce the floor slabs and these rods were continued through the construction joints. When completed, the pool had the appearance of an immense spoon with the end cut off by a circular vertical wall. The capacity of the pool is approximately 400,000 gals. The terraces around the beach were cut back at about a 1 to 4 slope and sodded.

The pool has been in use since July 1, 1923, and from the results shown, it appears that most of the objects desired have been accomplished. The fact that there are no step-offs except where the wall serves as a warning and that the floor slopes gradually from the water's edge, has served to minimize accidents, as was hoped. An 8-ft. square float anchored at the center of the wall circle also acts as a safety device, it being approximately 50 ft. to the shore or shallow water in any direction. The total cost of the pool, including pumping and chlorinating equipment, was $9,800.

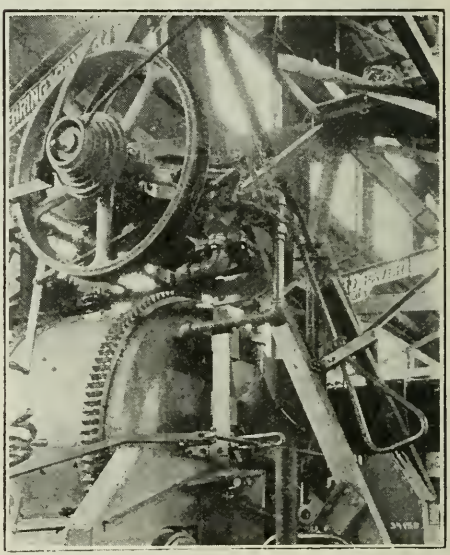
KOEHRING COMPANY ANNOUNCES NEW BALANCED VALVE

A new three-way balanced valve, the culmination of years of study and experimentation, has been perfected by the Koehring Company of Milwaukee and is now installed as standard equipment on Koehring 21E pavers.

Work on this new valve was begun in 1915 to overcome the difficulties of the old three-way valve with a metal-to-metal seat which never was wholly satisfactory, due to unavoidable leakage when the water which contractors are forced to use contained hard substances which cut the metal contacts.

This new valve completely eliminates this trouble as there are no metal-to-metal seats. All of the valve parts which come in contact with water are made of either bronze, brass, rubber or leather, preventing corrosion. It is balanced, automatically operated, permanent, non-freezing, self-draining and completely accessible.

The rubber valve discs and the leather plunger which receive the hardest usage, were removed from some valves that had



NEW THREE-WAY BALANCED VALVE NOW STANDARD EQUIPMENT ON KOEHRING 21E PAVERS.

been in service for several seasons. They were still in good condition and were continued in service. These rubber discs and leather plunger are standard Jenkins parts carried in any hardware store.

Inspection of the valve can be made very easily. Merely remove three bolts and one pin connection and the entire unit can be pulled out of the valve body. The valve can be dropped back into place without any fitting, adjusting or worry. To turn the three bolts down and make the pin connection to operating levers, is only a few minutes' work. The

valve is remarkable for its easy accessibility.

A removable house protects the valve and outside valve parts from stone, sand and cement which may drop from the charging skip.

An additional time-saving feature is the automatic opening of the valve to discharge water into the drum. The illustration shows the valve installed on a paver and the arm which opens the valve when the skip is raised. The time of opening the valve is adjustable in the valve operating mechanism. A hand control is also provided for operating the valve. The valve is balanced because the pressures are equal, which allows its easy operation.

For two years this type of valve has been installed on Koehring pavers in the field, functioning under the usual severe conditions under which a valve must operate. These valves were then returned to the factory from time to time for inspection and improvement. The valve now announced is the result of these years of expert designing, experimentation and test and is the last word in a paver three-way valve design.

The Koehring Company in addition to its line of concrete pavers and construction mixers, manufactures also cranes, draglines and power shovels.

SOME RECENT DEVELOPMENTS IN WATER SUPPLY PRACTICE

(Editor's Note: The following summary of the principal activities in the water works field, as related to the designer, builder and operator, is from the annual report of the Committee on Water Works and Water Supply of the American Society for Municipal Improvements. Members of the Committee are: George W. Fuller, Edward E. Wall and George G. Earl.)

1. The past year, and particularly the present autumn, has brought great anxiety to many water works officials owing to the protracted droughts. This applies particularly to the northeastern section of the country, in the New England and North Atlantic States. In the suburbs of New York, industries have been shut down for lack of water and neighboring cities have been called upon to help out adjoining communities, where this is practicable, to relieve the misfortunes of a water famine which are seldom, if ever, appreciated by the public until such a calamity befalls them.

2. The past year has continued to be an active period in the extension and addition to water works plants which all over the country are found in various stages of development. This is largely a result, of course, of the period of relative inactivity during and shortly after the war, although prices of labor and materials are higher than they were a year ago and are now about double prewar prices. There are many sections of the country where water works betterments are receiving more attention than for several years previously. Water shortage, threatened and actual, adequately explains this situation.

3. Real steps in the acquisition by municipalities of privately owned water localities. This is particularly true in the vicinity of New York, where agitations for years and decades at some plants have come to the front in some places have finally produced an agreement as to terms for acquisition. In part this is related to the need of bringing to an end deadlocks or disagreements as to a future program where the private company could not or would not provide needed extensions and where municipalities have held back with a view, in some cases, of picking up bargains in water plant purchases. Where factions have gotten together and agreed on terms of purchase, the figures, in most instances at least, have not approached either of the extremes earlier discussed.

4. Allocation of watersheds to different subdivisions of the states in the northeastern portion of the country is receiving more and more attention. This becomes a necessity as large cities in the Boston, New York and other districts find themselves obliged to look ahead to meet the growing needs of water supply at a date when the construction period already approaches the time remaining up to the date when additional supply must be forthcoming to guard against water famine.

5. Mechanical filters were introduced in Atlanta some 30 years ago on recommendation of the late Dr. Rudolph Hering. This type of filter, which is embodied in recent local extensions, has come into more and more general use. It has even entered the field in New England, where there is a new plant of this type recently put in operation at

Cambridge, Mass. Mechanical filters will also be used for the new water supply of Providence. They are also a part of the water purification projects at Albany and Poughkeepsie, N. Y., deriving their supply from the polluted Hudson River water. The raw water is first passed through a complete plant of the mechanical type and then through filters of the slow sand type.

6. The injunction suit, whereby the Mountain Water Supply Company sought to enjoin the discharge of coal mine drainage into the streams tributary to Indian Creek reservoir, was denied. An unusual amount of attention has been devoted during the year to the control of industrial wastes, particularly in Pennsylvania, where the jurisdiction of various state departments coming in contact with stream pollution has been reorganized by the creation of a new "Sanitary Water Board," having statewide jurisdiction.

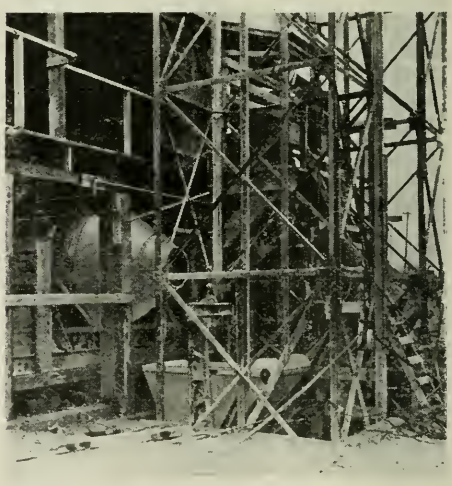
7. The newest step in the field of water treatment is the use of an iodin salt at Rochester, N. Y., for combating endemic goitre. This is in conformity with the recommendations of Dr. Goler, the City Health Officer. A two weeks' application of sodium iodide at the rate of 0.64 pound per million gallons has already been carried out by the Water Bureau there. It is expected that similar treatment twice a year of the public water supply of 25 million gallons daily will eliminate goitre, so prevalent in that city. Estimates place the number of preventable cases of goitre among children in Rochester each year at 2,000. This treatment is based on the correction of a deficiency in iodin found in certain waters of the Great Lakes regions and in the snow waters of Switzerland.

8. The new government standard for the quality of public water supplies used by the railroads and steamboats in interstate traffic has not yet been finally determined upon. Data from various localities throughout the country have been correlated and discussed for the consideration of the special Water Standards Committee appointed by the U. S. Public Health Service. This important step has revealed the fact that there are unfortunate instances where laboratories do not use the same methods of analyses and where those who express opinions on the results of analyses do not fully appreciate what the local data actually signify.

9. An important step in the unification of methods in handling the program of water standards is the conclusion of working committees of the American Public Health Association and of the American Water Works Association that the next edition of Standard Methods of Water Analysis should be gotten out jointly by these two associations. Authorization of such a step has been made by the governing bodies of the two associations, subject to the ratification of working details to be formulated jointly by the representatives of the two associations.

CONCRETING JONES ISLAND SEWAGE PLANT AT MILWAUKEE

Averaging 400 cu. yds. a day, two electrically driven Smith 40-S concrete tilting mixers are steadily advancing the work on the big sewage disposal plant at Jones Island, Milwaukee. It is expected that this job, which will require 64,000 yds. of concrete, will be completed about Dec. 1, 1923.



TWO ELECTRICALLY DRIVEN SMITH 40-S CONCRETE TILTING MIXERS CONCRETING JONES ISLAND SEWAGE PLANT.

These two mixers, each with a batch capacity of 1½ yds. and with batch hoppers, water tank and batch meter, are situated as the central units in the large mixing plant maintained on one of the long sides of the job. Extending in radial lines from this central mixing plant, chutes carry the concrete to all parts of the work, which, having outside dimensions of 650x750 ft., with the highest

point of concrete averaging 20 ft., gives some idea of the speedy and steady output required from the two mixers.

The job, which will cost well over three quarters of a million dollars by the time it is completed, is being directed by the Du Pont Engineering Co., of Wilmington, Del.

In addition to the two Smith 40-S tilting mixers, the central mixing plant includes two Insley steel hoisting towers of 1½-yd. capacity and 216 ft. high, so arranged that power is supplied to both hoists by one 100 H.P. double drum Thomas electric hoist. The aggregate is fed into the mixers from two overhead bins, each about 100 yds. capacity, these bins being fed by two 100-yd.-per-hour capacity bucket chain elevators. These, in turn, are fed by automatic chain belt feeders. The entire bin feeding apparatus is electrically driven.

When available, bottom dump cars deliver the sand and gravel direct to the bottom of the bins. When other cars are used, a 1-yd. clamshell derrick unloads the cars, this derrick also being used in handling the material for the 1,000-yd. stock pile which is maintained.

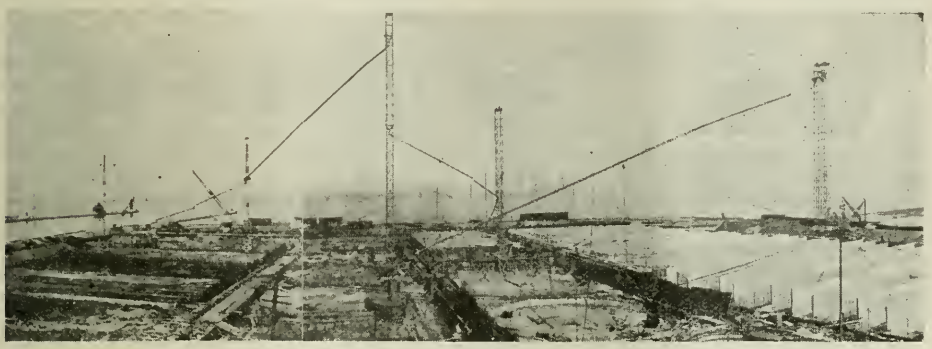
A cement bin of about 2-car capacity is located close to the bins, this being used for emergency storage only. A gravity trolley system, with cement containers of the bottom dump type, each about 8 bags capacity, is constantly dispatching the cement to the mixers direct from the cement cars as they arrive.

From the mixing plant the concrete is conveyed to the various parts of the job by a series of hoisting towers and several lines of chutes. The two main towers at the mixing plant supply one line of chutes 450 ft. long to an Insley re-hoist tower 196 ft. high. This re-hoist tower in turn supplies a 120-ft. tower, placed in the center of the job, which supports a line of chutes 280 ft. in length on each side of the tower, with a 50-ft. counterweight chute on each end which is used to pour the circular tanks in the center of the job.

An Insley guy derrick of 10-ton capacity, with 115-ft. mast and 100-ft. boom, which supports a double counterweight chute system with total operating radius of 170 ft., is being placed in four different working set-ups, and is supplied with concrete either direct from the two main hoist towers or from the re-hoist tower.

Williamsport cable is used throughout the job, the main suspension cable being 1½ ins. in diameter, the rest being 1¼ in. or 1⅛ in.

The two Smith tilting mixers are being operated alternately, and with specifications calling for 1½-minute mix, have reached a maximum of 600 yds. per day in one continuous pouring. The average per day, however, during the length of the job, has been 400 yds.



PANORAMIC VIEW OF JONES ISLAND SEWAGE PLANT UNDER CONSTRUCTION

EVIDENCE IN ZONING CASES

By Frank D. Stringham, Mayor, Berkeley, California

The law of this country is undergoing some very rapid changes—and in at least two departments of government without any change in the Constitution of the United States. I refer to zoning and to public utility regulation. Public opinion is the controlling factor in these matters. I have heard many lawyers say in the past ten years that they thought that the greater part of these so-called zoning laws were unconstitutional, and yet these same lawyers are coming to recognize that they have a fight on their hands

when they seek to resist them. I recently tried a case in the Supreme Court of Alameda County in which the city was attempting to keep in a residence district, a lot which adjoined a retail business district and opposite which stores were located. The court declined to hold any part of the zoning ordinance unconstitutional, although it held that this particular lot could not reasonably be included in the residence district. I had at all times during the trial let it be distinctly understood by the court that there was a distinction between holding the law unconstitutional and holding it unreasonable in its application to a particular piece of property.

People for Zoning

The people have come to comprehend, through the activities of zoning experts and repeated hearings before councils and commissions, that entire blocks or districts of a city may become blighted by the unrelated use or misuse of property, and that great economic loss may result. They have learned that this can be stopped by zoning regulation. The people learn these things quickly, just as the employer and employes in the various states in an incredibly short time learned that workmen's compensation acts were good and protected both employe and employer.

There are a few states where zoning laws have by far the best chance of being sustained by the courts and I would include in this category, California, New York, Massachusetts and Minnesota. That is because these communities have been better educated in the operation of districting laws.

Six years ago I published an article in which I said, "We want to keep out of court until the reasonableness of the law is better understood, and the practical operation of the plan has been tested by actual experience," and we did keep out of court for five years, to our great advantage.

A Job for Experts

Anyone interested in zoning or "graduated regulation" and who as city attorney or as a member of a council has to make, amend or defend zoning regulations should either employ an expert to assist him in making a decision or study the general principles of districting so that he can intelligently apply those principles to any given state of facts. Exceptions have to be made in difficult situations, but we should always keep it in mind that hard cases make bad laws, and are certain to be cited against and embarrass you later. It is safer and wiser to follow established rules of action than to make exceptions.

If you are compelled to go to court be sure and make it clear that even if it finds against you it is not necessary for the court to hold the zoning law unconstitutional. Introduce as part of your case as many specially prepared maps as possible showing the extent of zoning in your city, and maps of the smaller area in controversy with the character of the improvements shown by color or otherwise, and let the court see the extent of work done and effort made. We put in evidence testimony showing the number of preliminary hearings had before the council and of public meetings in the city in adopting the comprehensive zone ordinance, and also put on the stand the fire chief, a city planning consultant, a fire insurance adjuster, and a real estate man, all of whom qualified as experts, and through them proved that zoning contributes to the public health, welfare and safety, and attempted to prove that the same would be subserved by excluding retail stores from the lot in question. The court allowed, over objection, all the hypothetical questions to be answered.

Some Hypothetical Questions Used

I will give one or two examples of the hypothetical questions and answers which were allowed by the court to go in as evidence:

Real Estate Expert:

Q. I will ask you if a municipality has by legislation zoned a city into residential, business and factory zones, and said city has a population of sixty or seventy thousand people in it, and an area of approximately nine square miles. if in your opinion would such legislation, assuming, that it was based upon proper surveys and investigations, tend to increase and stabilize real estate values in that municipality?

A. Decidedly yes. It substitutes orderly development for haphazard growth, and without question helps to stabilize and increase values.

Q. Assuming that such legislation created so-called residential zones or districts from which retail stores and factories, generally speaking, were excluded, would the creation of such residential

district, in your opinion, promote the general welfare of the community?

A. Yes.

Insurance Expert:

Q. I want to ask you one question: Speaking from your general knowledge of fire insurance rates and the fire hazard with relation to various kinds of buildings, is or is not the risk of fire greater in buildings used solely as dwelling houses or in buildings used as a dwelling house in combination with stores, assuming that all other conditions are similar?

A. The physical and potential hazard of a store is measurably greater than that of buildings occupied solely for dwelling purposes.

Q. Would the rate of insurance on that building, on a concrete building on that location, be greater if it had stores in it than if it did not have stores?

A. Yes.

Fire Chief:

Q. In your opinion, is the fire hazard greater in any apartment house or hotel if stores are maintained in connection therewith than there would be if there were no stores in the apartment house or hotel? Is there any difference?

A. Yes, in stores, of course, it would depend a whole lot upon what the stores were to be used for. You take in most any mercantile establishment, there is always packing and unpacking of goods, and there is always more or less inflammable material around; and then another reason is that in a residential district there is somebody there at night, at all times, day and night, and in the mercantile district, as a rule, after stores are closed, there is nobody there that will discover a fire.

City Planning Expert:

Q. As an investigator of municipal housing conditions, and city planning and consulting, I will ask you if, in a city having a population of fifty or sixty thousand inhabitants, and having a total area of nine or ten square miles, an ordinance were in effect and in force dividing the city into residential, business and factory districts, and in such residential districts no new business stores of any kind were permitted to be built or maintained, whether or not, in your opinion, such enforced regulations would tend to promote the public welfare and safety?

A. I should say that, in my opinion, it would.

A Marked Achievement

The manner in which a comparatively small body of men have, in an incredibly short time, created a strong public opinion in favor of zoning is one of the most marked achievements of the last 20 years. In less than five years the courts, which are the most conservative of our governmental agencies, have come to recognize the validity of reasonable zoning regulations, such as those prohibiting business in residence districts and factories in business districts.

The United States was slow to start any application of the principle of use regulation, but having once accepted the doctrine, a large number of states have seized upon it with avidity and even carried it in some instances to dangerous extremes. In our enthusiasm for what our aesthetic taste demands we should constantly guard against exacting such a contribution from the individual, for the public good, that a good portion of his property is taken away from him without either compensation or benefit.

Essentials to Success

The success of zoning will therefore depend largely upon the wisdom of our local municipal councils and boards of trustees. A councilman or trustee, like a judge of the court, must be fair-minded and be able to sift out and weigh the relevancy and importance of evidence. I think he should suspend judgment until the case is fully heard and not make up his mind beforehand in executive session, or in committee of the whole. A judge does not try his case in chambers before the case is tried in court. I emphasize this matter because a council sitting in zoning cases is exercising semi-judicial functions, and the people will never be satisfied unless a council acts fairly and according to well settled principles. Your zoning case in court will have a better chance if the council has previously followed some city plan, or general rule, and not made compromises creating exceptions.

Police Power Abused

Recognizing the tremendous force of public opinion even in the face of constitutional limitations, I sometimes fear for the outcome of the exercise of the police power. Under the cloak of legal authority I have seen property practically confiscated for public use without much hope of redress, and perhaps even without the present knowledge of the

owner. I think that zoning regulations should be liberal in its first application to an unregulated area, and approach gradually its ultimate logical form. One has a better standing in court if the legislative body has been reasonable, if it has given the citizen a fair and ample hearing, and has treated all parts of a city with equal consideration.

There is no cheap way of zoning a city. The city must be prepared for an additional expense in employing experts, providing maps and publishing ordinances with amendments. The compensation for this outlay is the increased value resulting from better adapted uses of property and also the greater comfort and welfare of the community.

I am not attempting a technical discussion of legal authorities, or to describe different kinds of zoning laws. I assume that it is desirable that all cities should be zoned, and that the only reason any city has not adopted it is that it is not ready to incur the expense, or there is no one in the city who is qualified to educate the citizens to the point of demanding it. Two years ago this was a more difficult task than now—for there is a richer field of experience to draw from and the most obvious and best argument to be used in any campaign for charter amendment or zoning regulation is that other cities have done the same thing and operated most successfully under such amendment or regulation. I do not hesitate to say that the sooner any city has a reasonable zoning law, the better it will be for that city, and the expense will be proportionately less is taken early.

The foregoing paper by Mr. Stringham was presented before the recent annual convention of the League of California Municipalities.

VALUABLE TRADE LITERATURE

(Editor's Note: Copies of these catalogs and bulletins may be obtained on request by writing to the addresses given in the reviews, or by writing to Municipal and County Engineering.)

De Laval Flexible Coupling—The De Laval flexible coupling is described in a 12-page pamphlet issued by the De Laval Steam Turbine Co., of Trenton, N. J. This coupling, which has been developed for turbines or other motors geared or direct coupled to pumps, generators and similar machinery, consists of two opposed flanges mounted on the driving and driven shafts respectively. One flange carriage carries bolts or pins which enter holes bored in the opposing flange, but not coming into metallic contact with the latter, as the driving force is transmitted through steel lined molded rubber bushings slipped over the pins. The rubber supplies the flexibility required to take care of inevitable slight misalignment, does not require lubrication, absorbs shocks and is long lived and reliable. There is no constraint upon independent endwise motion of the shafts, and one shaft can be removed without disturbing the other. The peripheries of the flanges are ground to true cylinders and the faces to true planes to facilitate lining up. All parts are made to limit gauges and all similar parts are interchangeable.

Snow Removal Equipment—"The Caterpillar for Snow Removal" is the title of a 16-page pamphlet issued by The Holt Manufacturing Co. of Peoria, Ill. Many pictures of the equipment in operation are shown. There are several letters from users and much other informative matter on the art of snow removal and its economic justification. Caterpillar snow plows are fully illustrated and described. Brief specifications on caterpillar tractors of various sizes are also given.

Truscon Metal Lath Data Book—This is a 48-page book recently issued by the Truscon Steel Co., Youngstown, Ohio. It is the most complete book ever published on metal lath. It is the result of an investigation covering more than a year. During that period nearly all the practical uses of metal lath were studied. The full pages of architectural details are not built on theory but on practical experience in the field. The specifications used throughout are adopted from those compiled by the principal metal lath manufacturers with the co-operation of the American Specification Institute. Solid plaster partitions, walls, floors, roofs, attached and suspended ceilings, together with practical information for interior plastering and exterior stucco work, are just a few of the subjects that are fully covered. The Truscon Metal Lath Data Book meets the requirements of the practical plastering contractor as well as the architect or engineer seeking technical information. The book is replete of tables of loads and

properties of all types of Truscon Hy-Rib Metal Lath. The distinctive thing about this data book is that it contains only the boiled down essence of practical metal lath information.

Concrete Mixers—The T. L. Smith Company, Milwaukee, Wis., is distributing a small folder descriptive of two of the Smith line of concrete mixers—the new 4-S Tilter (half-bag) and the 7-S Non-Ttilting Mixer (full-bag). Special reference is made to the newly designed and much simplified device which is now used on the 7-S for operation the discharge chute.

Underfeed Stoker—The new model Westinghouse Underfeed Stoker is illustrated and described in a 16-page catalog recently issued by the Westinghouse Electric & Manufacturing Co., Stoker Dept., South Philadelphia Works, Philadelphia, Pa. This model is the culmination of 35 years' experience in building mechanical stokers. This multiple retort stoker gives positive control of the fuel bed at all rates of combustion. An agitating element provides a means of maintaining minimum loss due to combustible in the refuse. Many types and sizes are illustrated in the catalog, including double and single dump grates and double and single roll ash discharge devices.

Lime Plaster Specifications—"Standard Specifications for Lime Plaster" is the title of Bulletin No. 305, 16 pages, recently issued by the National Lime Association, Washington, D. C. This bulletin is the result of several years' study of field conditions and has been prepared in conjunction with representatives of the engineering and architectural professions as well as expert plasterers and producers of lime. The specifications are in such form that they may be quoted directly and included in an architect's complete building specifications, or, if desired, the short form may be used and the contractor referred to the standard specifications. This new bulletin is 8½x11 ins. in size and marked for standard A. I. A. filing. Each specification is on a separate page and the arrangement is logical and simple. The bulletin contains only specifications.

Street Lighting — The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has printed in booklet form a paper entitled: "Bright Streets Are Busy Streets," presented by Mr. L. A. S. Wood of the Westinghouse Co. at the 28th annual convention of the International Association of Municipal Electricians. Some of the interesting subjects discussed by Mr. Wood are City Zoning of Street Lighting, Street Lighting Defects and Their Remedy, the Economy of Good Street Lighting, and the Effect of Good Lighting on Property Values. Copies of this leaflet, which is known as Reprint 166, may be had upon application to the Westinghouse Co.

Brick Paving—"The A B C of Good Paving" is the title of a 16-page booklet recently issued by the National Paving Brick Mfrs. Assn., Engineers Bldg., Cleveland, Ohio. The following subjects receive special attention: Wearing Surface, Base and Subgrade, Drainage, and Artificial Bases.

Paving Guards—Godwin Steel Paving Guards are illustrated and described in a 4-page pamphlet issued by the W. S. Godwin Co., Inc., 12 E. Lexington St., Baltimore, Md.

Water Filters and Filtration Equipment—This is the title of Bulletin No. 105 recently issued by the Permutit Co., 440 Fourth Ave., New York. It contains 24 pages. The data given is comprehensive and authoritative and fully covers the theory and practice of modern filter design and construction and shows, by detail drawings, the method of operation.

Power Drag Scrapers—The Sauerman line of power drag scrapers is illustrated and described in pamphlet No. 20 recently issued by Sauerman Bros., 438 S. Clinton St., Chicago. It contains 32 pages and is very fully and attractively illustrated with detailed views of the equipment and its operation. Special attention is devoted to Direct Loading to Cars and Trucks, Small and Medium Gravel Pit Operations, Large Sand and Gravel Pits, Making Cuts and Fills and Grading, Stripping Overburden and Similar Work, and Storing and Reclaiming Loose Materials. Valuable ideas are given on adapting the equipment to many difficult and unusual jobs.

Lime in Construction—This is the title of Bulletin 306-A, of 80 pages, issued by the National Lime Association, Washington, D. C. It relates particularly to Mortar, Plaster, Stucco and Concrete. It shows by observation and test data from quoted authorities he durability of lime, and its insulating properties, adequate strength, working qualities and economic advantages.

Lime in Concrete—This is the title of

Bulletin No. 308 issued by the National Lime Association, Washington, D. C. It contains 24 pages. The use of lime in concrete as approved by engineers, architects and contractors is illustrated and described.

Road and Street Maintainer—The "Gray Giant" combination road and street maintainer is illustrated and described in a folder issued by the Gray Tractor Co., Inc., Minneapolis, Minn.

Asphalt in Highway Construction—"Uses of Asphalt in Highway Construction" is the title of Circular No. 24, issued by the Asphalt Association, 25 W. 43rd St., New York. It is an extract of paper read by I. W. Patterson, Chief Engineer, Rhode Island State Board of Public Roads, at a convention of the Canadian Good Roads Assn.

Asphalt Paving—The Asphalt Association, 25 W. 43rd St., New York, recently issued the following new publications: "How American Cities Are Paved." This is Circular No. 9, giving the results of a comprehensive paving census showing that asphalt is the most widely used paving material. Circular No. 22, by Prevost Hubbard, gives results of the Bates Road experiments in 1922 with special reference to asphalt pavements.

ENGINEERING EMPLOYMENT SHOWS SLIGHT RECESSION

Employment conditions affecting engineers reflect considerable irregularity with special divergencies between the trends in different industries and engineering endeavors is reported by the Employment Department of the American Association of Engineers. Numerous inquiries are being received from men from all sections of the country, desiring to make new affiliations, or who report the completion of their work, indicating that a slight recession in employment is apparent. In September there was practically no unemployment among engineers, but during October some unemployment was noticed in different quarters. Engineering employment from now on will continue to slacken from the normal trend of conditions, and no apparent advance will be noticed until about Feb. 15, 1924.

The engineers mostly affected at this time are civil engineers, particularly those on construction work including superintendents, instrumentmen, and general field engineers; also engineers with oil companies in the mid-continent field. There is practically no demand for men on irrigation, drainage, hydraulic or construction work at this time. Manufacturing and industrial companies have reduced their technical staff although a few lines continue activity, such as machine tools, railway equipment and automobile manufacturers. The greatest demand at this time is for architectural engineers and draftsmen. A fair demand is evident for highway engineers, especially designers on plans and bridges. The railroad field for engineers is practically dormant. The electrical industry is fair with a good demand for junior men for minor positions and a fair demand for a few electrical technical experts. The chemical and mining fields have not shown any changes in employment.

Positions for engineers on the Pacific Coast and Southern California are fair. In the Northwest, conditions are tightening up with little work for engineers in the states of Washington, Montana and Idaho. The central states are fair for employment. The Eastern section is not very desirable for employment; more men looking for positions open. The South is starting considerable activity with a good demand for engineers of the junior grade. The greatest unemployment of engineers at the present time is in the Northwest and in the Eastern section of the country.

FORCE ACCOUNT CONSTRUCTION

To the Editor:—

I noted with interest your publication of my paper before the Public Ownership Conference at Toronto, on Page 189 of your October, 1923 issue, and also the editor's introductory note on same.

The only thing I have to criticise about the note is the use of the word "enthusiastic." I may have been enthusiastic on this point when I went to Milwaukee in 1910, and was 26 years old, but I can assure you that, now that I am in my fortieth year, the enthusiasm has quite cooled down. My conviction on the point still remains, but it is based on a great many years of careful consideration of the subject, and experience with work done both by day labor and by contract.

Very truly yours,

CHARLES A. MULLEN.

Director of Paving Department, Milton Hersey Co., Ltd., 84 St. Antoine St. Montreal, Quebec, Oct. 26, 1923.

The King of the Black Tops says:

"As the old rings out, and the new rings in, our wish for you is that 1924 will be

THE BEST BY EVERY TEST"

THESE MEN ARE GOING AGAIN

The Convention each year is attended by men from every section of the country. Here is what two representative men in the highway construction field, one a contractor and the other an engineer, have to say about the Convention and Show.

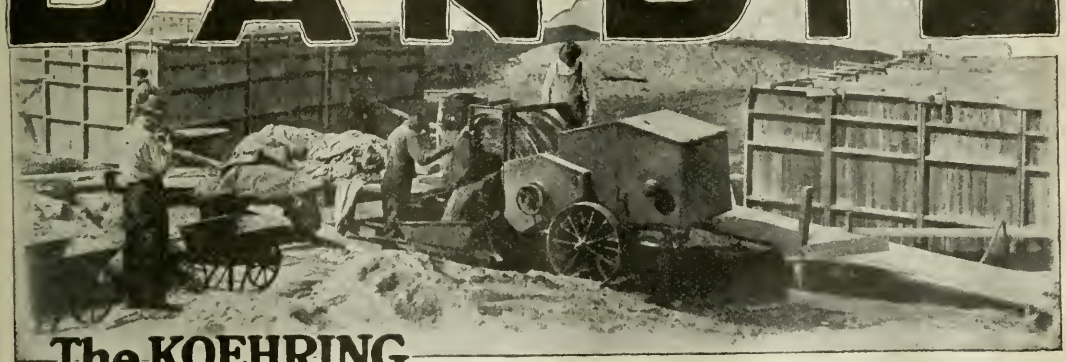
H. B. Sproul, president of the H. B. Sproul Construction Co., Inc., with offices in Peekskill, N. Y., and Scranton, Pa., who is well known in the East, says:

> "I attended last year's Road Show at Chicago and am going again if my health will permit. Last year I was accompanied by General Superintendent H. M. Unangst, and we considered the time and money spent was the best investment we ever made as we were able to study different machinery and make a comparison with the different units right before us. We would not miss this year's show for worlds."

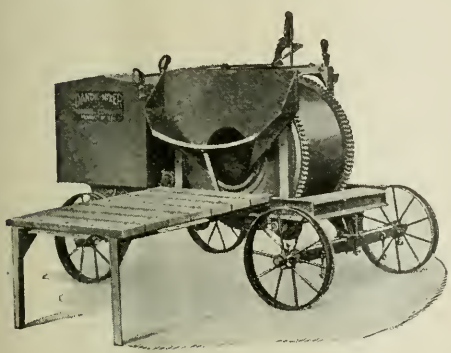
B. H. Piepmeier, Chief Engineer, Missouri State Highway Commission, the man drafted by Missouri from Illinois to put through a big road construction program, says:

> "I expect to arrange, if possible, for members of the Commission as well as a few of the engineers from this department to attend the Road Builders' Association meeting in Chicago in January.
>
> "It is needless to say that I am making full plans to be present, as I do not recall having missed a single meeting in the last ten years. My purpose in having the Commission and engineers attend this meeting is that they may acquaint themselves with all modern equipment that is on the market suitable for road construction and maintenance.
>
> "The Convention offers an opportunity for engineers and contractors to study and compare different types of machines. It further offers an opportunity to meet engineers and contractors who are interested in various phases of road work.
>
> "The program given in connection with the exhibit has always been of the highest class and much favorable information can be obtained from the papers, talks and discussions offered.

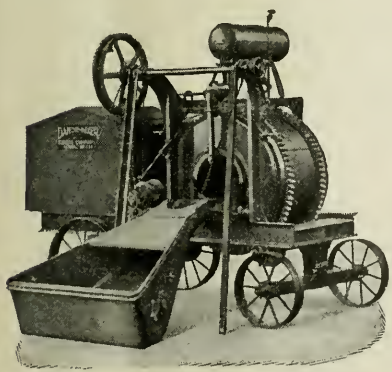
DANDIE



The KOEHRING Light Mixer



104 S—4 Cubic Feet Mixed Concrete



107 S—7 Cubic Feet Mixed Concrete

Get the Price— Get the Specifications

NO, it's not the cheapest mixer in price — but it is the greatest *value* in the light mixer class and it is within the light mixer price range.

It will outwork, outwear and outlast ordinary light mixer construction. It will still have a long profitable future ahead of it, when the ordinary light mixer is costing you big money to keep it out of the junk pile.

Send back the coupon. Get the Dandie catalog that informs you how to judge mixer values. You'll find it a practical, helpful, money-saving booklet.

Dandie Capacities

4 and 7 cu. ft. mixed concrete, steam and gasoline. May be equipped with power charging skip, low charging platform, light duty hoist, automatic water measuring tank. Mixes mortar as well as concrete. Send back the coupon today.

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Manufacturers of Concrete Mixers, Cranes, Draglines and Shovels
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Please send me Koehring Dandie Mixer Catalog No. P-10 and give full information on interchangeability for mixing concrete and mortar.

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Manufacturers of Koehring Heavy Duty complete lines of Mixers and Cranes, Draglines and Shovels, Pavers, Construction Mixers and Dandie Light Mixers, Gasoline Cranes, Excavators and Shovels. See these at our exhibit on main floor.

OFFICIAL PROGRAM

AMERICAN ROAD BUILDERS' ASSOCIATION

Congress Hotel, Chicago
Jan. 15-17, 1924

Opening Session

Tuesday morning, Jan. 15, 10 A. M.

Chairman—Frank Page, President, American Road Builders' Association.

President's Address
Frank Page, Chairman State Highway Commission of North Carolina, Raleigh, N. C.

Highway Improvement a Continuing Business
Thomas H. MacDonald, Chief, Bureau of Public Roads, Washington, D. C.

MATERIALS AND DESIGN

Tuesday afternoon, Jan. 15, 2 P. M.

Chairman—S. L. Squire, Deputy Minister of Highways, Ontario, Toronto, Ont.

Recent Development of Bituminous Base and Sand-Asphalt Road Construction.
E. R. Olbrich, National Research Council, Washington, D. C.

Outstanding Problems in Highway Bridge Design—Surface, Width, Vulnerability, Ground Plan
E. F. Kelley, Senior Highway Bridge Engineer, Bureau of Public Roads, Washington, D. C.

Smoothness as a Factor in Pavement Life
A. T. Goldbeck, Chief Division of Tests, Bureau of Public Roads, Washington, D. C.

TRAFFIC AND MAINTENANCE

Wednesday Morning, Jan. 16, 10 A. M.

Chairman—R. Keith Compton, Chairman Paving Commission, Baltimore, Md.

Traffic Surveys—Methods and Costs
H. E. Hamlin, Superintendent of Repairs, Connecticut State Highway Commission, Hartford Conn.

Traffic Surveys—Findings and Deductions and their Lesson for the Road Engineer
J. G. Mackay, Bureau of Public Roads, Washington, D. C.

Snow Removal—Organization, Methods and Equipment
Edward E. Reed, Assistant State Highway Engineer, New Jersey State Highway Commission, Trenton, N. J.

Central Plant Maintenance—Possibilities for Large Concentrated Mileages
Leroy C. Smith, Engineer Manager, County Road Commissioners, Wayne County, Detroit, Mich.

Highway Traffic Accidents—Classifications and Causes
N. M. Isabella, Assistant Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

ADMINISTRATION

Wednesday Afternoon, Jan. 16, 2 P. M.

Chairman—Frank Page, President American Road Builders' Association.

State Cement Manufacture a Highway Administration Policy

(1) **Merchandising and Transport Conditions Which Prompted Consideration of State Purchase and Manufacture of Cement Road Building Materials.**
B. F. Piepmeier, State Highway Engineer of Missouri, Jefferson City, Mo.

(2) **State Purchase and Storage as a Means of Regulating Cement Supply and Price Without State Manufacture.**
C. N. Connor, Construction Engineer, North Carolina State Highway Commission, Raleigh, N. C.

Election of Officers

Business Session

JOINT SESSION WITH THE
ASSOCIATED GENERAL CONTRACTORS OF AMERICA

Thursday Morning, January 17, 10 A. M.

Chairman—John W. Cowper, President, Associated General Contractors of America, Buffalo, New York.

Purpose and Progress of Equipment Standardization
C. E. Bement, President Novo Engine Co., Lansing, Mich.

Standard Highway Contracts a Public Service
General R. C. Marshall, Jr., General Manager, Associated General Contractors of America, Washington, D. C.

Economic Aspects of Day Labor Construction
Arthur S. Bent, Bent Brothers, Los Angeles, California.

Bonds as a Gauge of Responsibility
H. H. Wilson, Managing Partner, Winston & Co., Harrisburg, Pa.

CONSTRUCTION

Thursday Afternoon, Jan. 17, 2 P. M.

Chairman—Frank Page, President American Road Builders' Association.

Can We Cut Down the Curing Period for Concrete Roads?
H. F. Clemmer, Testing Engineer, Illinois Division of Highways, Springfield, Ill.

Simplified Practice a Service to Industry
R. M. Hudson, Division of Simplified Practice, Department of Commerce, Washington, D. C.

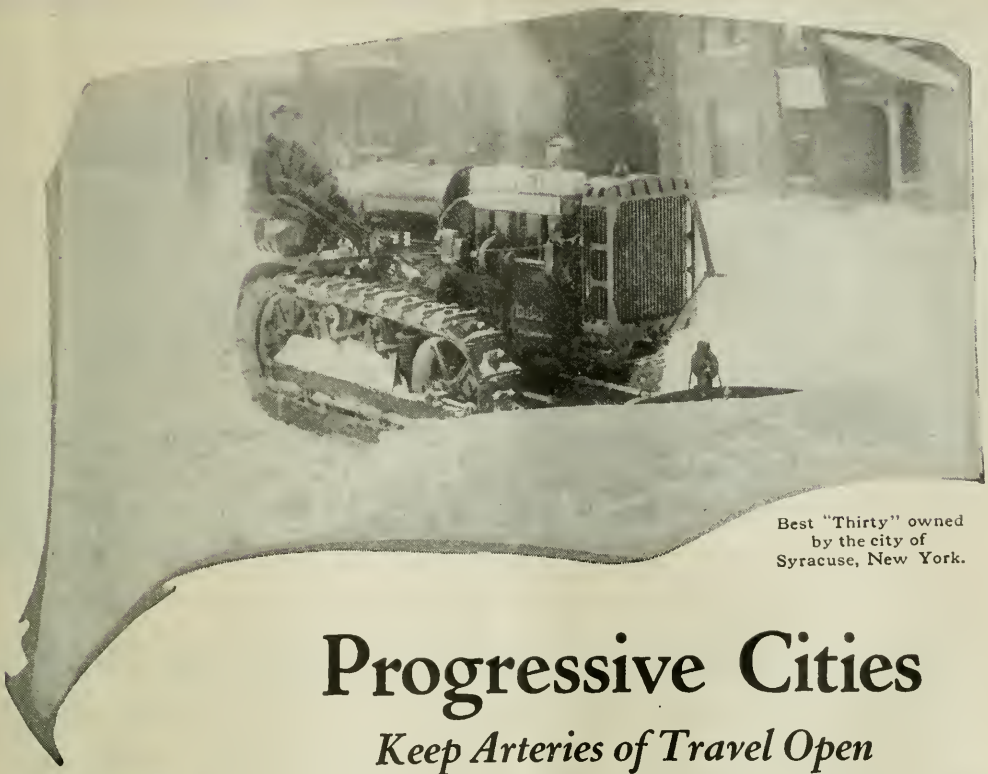
Controlling the Distant Units in a Highway Construction Organization
O. M. Kipp, Construction Engineer, Minnesota Highway Department, St. Paul, Minn.

WHY YOU OUGHT TO GO TO THE ROAD SHOW

The Good Roads Show has for many years been an integral part of the annual Convention of the American Road Builders' Association. The manufacturers of machinery for building and maintaining roads and the producers of road materials have made the Road Show something which no contractor or public official in the highway industry can afford to miss.

These manufacturers take advantage of the Show to display the latest types of road machinery, equipment and materials. The man who attends the 1924 Good Road Show will have a chance to see every new piece of road building equipment that will be at work on the highways of the country next year. Most of the exhibitors at the Road Show bring their men to Chicago from all parts of the country for the Show and it is possible to meet there nearly every one identified with the distribution of road building equipment and materials.

The 1924 Show is going to be bigger and better than ever. It will be well managed and every one who attends will feel himself well repaid.



Best "Thirty" owned by the city of Syracuse, New York.

Progressive Cities

Keep Arteries of Travel Open

Just off the Press!

Reasons for snow removal—evidence of the popular demand for it—and information on equipment are contained in our new and authoritative book on snow removal entitled "The Open Road."

Your copy will gladly be mailed on request. *Send for it!*

"After a demonstration with a C. L. Best 'Sixty' Tractor and a snow plow, we were convinced our city could not afford to be without the equipment," writes the Mayor of a Wisconsin city.

No progressive city will allow a snow fall to block its streets and stifle business activity. Tractors have made removal work too easy for that. And the rest of the year they may be used for street construction and maintenance work.

C. L. BEST TRACTOR CO.

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BEST TRACTORS

REGISTRATION

PLANS have been made so every one who attends may register with the least possible effort. Registration blanks have been printed for advance distribution. These blanks are in the form of tickets of admission which are to be filled out and presented at the entrance to the Road Show. When the registration blank is presented there the individual will receive a badge which will admit him to the Road Show at any time during the rest of the week.

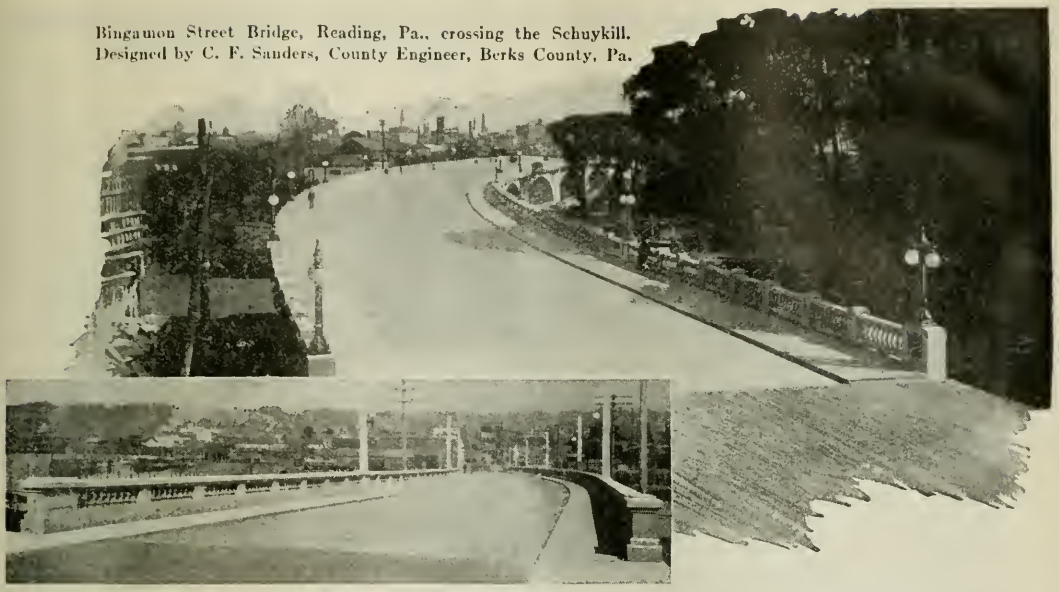
No admission is charged to the Road Show. No one will be admitted, however, until he fills out and presents a registration blank to get his badge.

Registration blanks may be obtained at the entrance to the Coliseum. They also will be mailed free on application by mail to the American Road Builders' Association, 37 West 39th Street, New York City. Exhibitors have agreed to help distribute them through their field organizations.

This plan of registration should insure that all may be listed without any delay or inconvenience.

THE DAILY NEWSPAPER

THOSE attending the Convention and Road Show will be able to keep in touch with what is going on by reading the "Highwayman," the daily newspaper which will be published on all four days that the Convention is in session. This newspaper will be distributed free of charge and will contain the full program for the day as well as a review of the events of the previous day.



Bingamon Street Bridge, Reading, Pa., crossing the Schuykill. Designed by C. F. Sanders, County Engineer, Berks County, Pa.

Bridge at Olympia, Wash. Elastite Expansion Joint used.

Protecting great bridges against temperature

TEMPERATURE fluctuation, and the consequent expanding and contracting of these great concrete masses, are rendered harmless to the durability of big bridges and viaducts by the installation of Elastite Expansion Joint at regular intervals.

The fact that Elastite Expansion Joint, "the sandwich joint," is handled as a slab, in any dimension and thickness, makes installation comparatively simple and easy. It is the practical joint used exclusively by practical engineers and contractors. It is easily cut to shape with an old saw, or can be supplied cut to exact fit to meet your requirements.

When you need "joint," remember that there are big stocks of Elastite Expansion Joint in seventeen cities. Your order will be immediately shipped to your job from the nearest point. Send for sample and all the facts.

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Carey Elastite Expansion Joint is used in these bridges and viaducts

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Augusta, Ga.
Arch. W. Butts Memorial Bridge
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Cincinnati, Ohio
Park Avenue Bridge
Fort Wayne, Ind.
Harrison Street Bridge
Galveston, Texas
Galveston Causeway
Hawkinsville, Ga.
Ocmulgee River Bridge
Kansas City, Mo.
Benton Boulevard Viaduct
Little Rock, Ark.
Broadway Bridge
Oahu, Hawaii Heeia Viaduct
Pulaski, New York
Salmon River Bridge
Reading, Pa.
Bingamon Street Bridge
St. Louis, Mo.
Chauteau Avenue Viaduct
St. Louis, Mo.
Jefferson Avenue Bridge
Laredo, Texas
Laredo International Bridge
Washington, D. C. Key Bridge
Watertown, New York
Grove Street Bridge

Carey Elastite

TRADE MARK REG. U.S. Pat. Office

EXPANSION JOINT PROVED AND ACCEPTED

Carey Elastite Expansion Joint is an asphaltic body, formed of a high-grade asphaltic compound carefully refined and tempered, sandwiched between two walls of asphalt-saturated felt forming an elastic, compressible joint. It is made in lengths, widths and thicknesses as required, can be cut to crown or to any special shape and comes to the job ready to use.

12-23

HOTELS

As every one knows, Chicago has plenty of good hotels and can take care of any convention crowd. On the other hand, it is advisable for all who expect to attend the Convention to write at once and make reservations. No matter how many hotels there are, it is impossible for them to accomodate every one at the last minute. The hotel manager has to plan his campaign just as any other business man does and you can help yourself and the hotel at which you wish to stop by making your reservation without further delay. A list of the leading Chicago hotels follows. All of these are recommended by the Chicago Association of Commerce which also maintains a Bureau which you may call up in the event that the hotel you select has not room for you. The telephone number of this Bureau is Main 4808.

Alexandria (300), Rush and Ohio Sts.	$1.50 up
Ambassador (500), N. State and Goethe Sts.	3.50 up
Atlantic (750), Clark St., Near Jackson Blvd.	2.00 up
Auditorium (500), Michigan Blvd., at Congress	2.50 up
Bismarck (300), 171-185 W. Randolph St.	1.50 up
Blackstone (700) Michigan Blvd. and Seventh St.	5.00 up
Board of Trade (200), 321 S. LaSalle St.	2.00 up
Bradley (300), Rush St. and Grand Ave.	1.25 up
Brevoort (500), 120 W. Madison St.	2.00 up
Briggs (300), Randolph and Wells Sts.	1.25 up
Chicago Beach (1,350), 51st St. on the Lake Shore	3.00 up
Congress Hotel and Annex (1,500), Michigan Blvd. and Congress	3.00 up
Colonial, 63rd and Kenwood	1.25 up
Cooper-Carleton (500), Hyde Park Blvd., at 53rd	3.50 up
Darlington (125), 4700 N. Racine Ave.	1.50 up
Del Prado (400), Midway Blvd. and Jackson Park	2.50 up
Drake (1,200), Michigan Ave. and Walton Place	4.00 up
Drexel Arms (250), Drexel and Oakwood Blvds.	2.00 up
Edgewater Beach (600), 5300 Sheridan Road	3.00 up
Elms (150), 53rd St. and Cornell Ave.	2.00 up
Fort Dearborn (1,000), LaSalle and Van Buren Sts.	1.95 up
Gladstone (500), 62nd and Kenwood Ave.	1.50 up
Grant (250), Dearborn and Madison Sts.	1.50 up
Grasmere, 4621 Sheridan Rd.	3.00 up
Great Northern (550), Jackson, Dearborn and Quincy Sts.	2.00 up
Hayes (300), 64th and University Ave.	1.50 up
Hyde Park (400), Hyde Park Blvd. and Lake Ave.	2.50 up
Jackson Park Tavern, 67th St. and Cornell Ave.	3.00 up
Lakota (350), Michigan Blvd. and 30th St.	1.50 up
LaSalle (1,800), Madison and LaSalle Sts.	2.00 up
Lexington (750), Michigan Blvd. and 22nd St.	2.00 up
Lorraine (160), 417 S. Wabash Ave.	2.50 up
Luzerne (100), Clark and Center Sts.	2.00 up
Majestic (300), Quincy St., Between State and Dearborn	2.00 up
Melbourne (150), 4625 N. Racine Ave.	3.00 up
Metropole (300), Michigan Ave. and 23rd St.	1.50 up
Montezuma Lodge, 908 Windsor Ave., per week	10.00 up
Moraine (250), Highland Park	2.50 up
Morrison (1,000), Clark and Madison Sts.	2.50 up
New Gault (200), Madison and Market Sts.	1.50 up
New Southern (350), Michigan Blvd. and 13th St.	1.50 up
Palmer House (1,000), State and Monroe Sts.	2.00 up
Parkway (400), Lincoln Park West and Garfield	2.00 up
Planters (300), Clark and Madison Sts.	2.00 up
Plaza (600), North Ave. and N. Clark St.	2.00 up
Plymouth (250), 4700 Broadway	2.00 up
Sheridan Plaza (300), Sheridan Road and Wilson Ave.	2.50 up
Sherman (1,500), Clark and Randolph Sts.	2.00 up
Sisson (500), 1725 E. 53rd St.	5.00 up
Somerset (600), Sheridan Road at Argyle	4.00 up
Sovereign Kenmore at Granville Ave.	4.00 up
Stock Yard Inn (450), W. 52nd St. and Halsted	1.50 up
Strand (300), 63rd St. and Cottage Grove Ave.	1.50 up
Trenier (150), 409 Oakwood Blvd.	2.00 up
Victoria (500), Clark and Van Buren	1.50 up
Virginia (450), Rush and Ohio Sts.	2.50 up
Warner (350), 33rd St. and Cottage Grove Ave.	1.00 up
Washington (200), Washington Blvd., Between LaSalle and Wells	2.00 up
Webster (450), Lincoln Park West at Webster	4.00 up
Windemere (300), 56th St. and Cornell Ave.	5.00 up
Windsor Clifton (350), Wabash Ave. and Monroe St.	1.50 up

30 years ago many streets were paved in this way:—first the sub-soil was graded, then a very thin layer of stone, cinders, or sand was spread from curb to curb; finally a brick surface, sand filled, or sometimes tar-filled was laid over this base.

These pavements, laid when Grover Cleveland was president, in many cases are not perfect today. The surface may be rough and need relaying—on a new base designed to meet present traffic needs.

The point is this—*no other paving material laid under those conditions could possibly be in service today.*

Only paving brick could stand such treatment and those brick have stood it thirty years and more virtually without attention through all that long period.

And, how are the brick? Invariably as good as the day they were laid except for slight cobbling on the upper edges where the filler wore away years ago.

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MANUFACTURERS ASSOCIATION
ENGINEERS BLDG. CLEVELAND, OHIO

VITRIFIED
Brick
PAVEMENTS
OUTLAST THE BONDS

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Albion, Ill.

Alton Brick Company
Alton, Ill.

Barr Clay Company
Streator, Ill.

Binghamton Brick Company
Binghamton, N. Y.

Cleveland Brick & Clay Company
Cleveland, Ohio

Clydesdale Brick & Stone Co.
Pittsburgh, Pa.

Coffeyville Vitrified Brick & Tile Co.
Coffeyville, Kans.

Collinwood Shale Brick Company
Cleveland, Ohio

Corry Brick & Tile Company
Corry, Pa.

Francis Vitric Brick Company
Boynton, Okla.

Georgia Vitrified Brick & Clay Co.
Augusta, Ga.

Globe Brick Company
East Liverpool, Ohio.

Hammond Fire Brick Company
Fairmont, W. Va.

Hocking Valley Brick Company
Columbus, Ohio.

Independence Paving Brick Co.
Independence, Kans.

Mack Mfg. Company
Wheeling, W. Va.

C. P. Mayer Brick Company
Bridgeville, Pa.

Medal Paving Brick Company
Cleveland, Ohio.

Metropolis Paving Brick Co.
Pittsburg, Kansas.

Metropolitan Paving Brick Co.
Canton, Ohio.

Mineral Wells Paving Brick Co.
Mineral Wells, Texas.

Moberly Paving Brick Company
Moberly, Mo.

Murphysboro Paving Brick Co.
Murphysboro, Ill.

Patton Clay Mfg. Company
Patton, Pa.

Peebles Paving Brick Company
Portsmonth, Ohio

Pittsburgh Paving Brick Company
Pittsburgh, Kansas.

Purington Paving Brick Company
Galesburg, Ill.

Southern Clay Mfg. Company
Chattanooga, Tenn.

Springfield Paving Brick Company
Springfield, Ill.

Sterling Brick Company
Olean, N. Y.

Streator Clay Mfg. Company
Streator, Ill.

Thornton Fire Brick Company
Clarksburg, W. Va.

Thurber Brick Company
Ft. Worth, Texas.

Toronto Fire Clay Company
Toronto, Ohio

Trinidad Brick & Tile Company
Trinidad, Colo.

Veedersburg Paver Company
Veedersburg, Ind.

Western Shale Products Company
Fort Scott, Kans.

Westport Paving Brick Company
Baltimore, Md.

SPECIAL REDUCED RAILROAD RATES

THE various railway passenger associations covering the United States and Canada have granted a special reduced rate under the "Certificate Plan" of one and one-half fares for the round trip, covering all points in their territory to and from Chicago. The reduced fare is not only available for members of the American Road Builders' Association and delegates to the congress but for dependent members of their families. In order that they may profit by the reduced fare, delegates are urged to carry out the following directions:

1. Be sure when purchasing your going ticket to ask the ticket agent for a convention certificate. Do not make the mistake of asking for a receipt. The certificate must be secured at the time the ticket is purchased. See that the ticket reads to the point where the convention is to be held and no other. See that your certificate is stamped with the same date as your ticket. Sign your name to the certificate or receipt in ink. Show this to the ticket agent.

2. Ask your home station whether you can procure through tickets to the place of meeting. If not, buy a local ticket to the nearest point where a certificate and through ticket to place of meeting can be purchased. Find out from local agent dates between which reduced rates are effective.

3. Immediately upon your arrival at the meeting, present your certificate to the endorsing officer, E. A. Birchland, Secretary, as the reduced fare for the return journey will not apply unless you are properly identified as provided for by the certificate.

4. A Joint Agent of the carriers will be in attendance during the convention week to validate certificates. If you arrive at the meeting and leave for home prior to the arrival of the Joint Agent, or if you arrive at the meeting after the Joint Agent has gone, you cannot have your certificate validated, nor secure the benefit of the return reduction.

No refund of fare will be made on account of failure either to obtain a proper certificate, or on account of failure to have the certificate validated.

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Du Pont Products Exhibit, Atlantic City, N. J.

EXPLOSIVES ~ SERVICE

JOINT SESSION WITH ASSOCIATED GENERAL CONTRACTORS OF AMERICA

At the American Road Builders' Association Convention this year, there will be a joint session with the Associated General Contractors. This will be held on Thursday, January 17th, and the presiding officer will be John W. Cowper, President of the Associated General Contractors of America. Mr. Cowper's reasons for arranging this joint session are set forth in the following letter:

> "As President of the Associated General Contractors I was very much interested in setting the date of our annual convention to concur with and immediately follow the Road Show because I believed it would be of the greatest interest to a great many, if not all, of our members to see the exhibit which you put up.
>
> "I have attended one Show and then only for a very few minutes but sufficiently long to gain a very excellent impression of what benefits a contractor, whether he be in the road building game or some other line of construction, can get from a visit to this Show.
>
> "I expect personally to spend considerable time looking over the Road Show Exhibit and confidently count on a great deal of personal benefit that will react in my business to our good and I look forward to great success from holding our Contractors' meeting concurrently with yours."

Hauling 100 tons daily over the Sudan Desert

S. Pearson & Son, Ltd., of London, one of the largest contracting firms in the world, are building an enormous dam across the river Nile to provide a base water supply in the Sudan, and are also building 650 miles of irrigation canals. In beginning this great project, the Engineering Department of S. Pearson & Son, Ltd., was confronted with the almost insurmountable task of transporting machinery, fuel and supplies under extreme difficulties of soil and climate, and in a country where roads do not exist.

Various types of automotive equipment and tractive machinery were tried out under expert supervision but all proved inadequate. ***For a scheduled daily transportation of 100 tons over an average haul of eight miles, no solution of the problem was possible except by the use of "Caterpillar"* Tractors. Consequently, a fleet of 10-Tons was purchased for this important project.***

The unequaled performance of "Caterpillar" Tractors in hauling great cargoes in the military service of the Allied Governments throughout the War, is reflected by the selection of "Caterpillars" by one of England's foremost contracting firms, to accomplish work too difficult and too important to entrust to any other method or machine.

In every tongue, "Caterpillar" is a synonym for power, traction and economy. We invite correspondence from engineers, contractors, public officials and industrial firms in regard to any problems of overland hauling, dirt moving, snow removal or construction work.

**There is but one "Caterpillar"—Holt builds it.*

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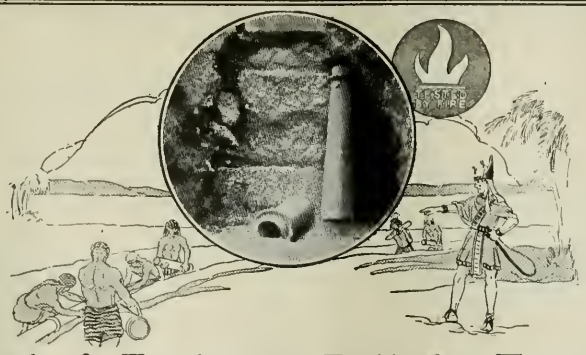
FOUR MEN WHO ARE WORKING TO MAKE THE 1924 CONVENTION AND SHOW THE BEST YET

Frank Page, President of the American Road Builders' Association, is also Chairman of the North Carolina State Highway Commission. He is the man chiefly responsible for the great and comprehensive plan of highway development which is bringing North Carolina to the front as one of the most progressive states in the road construction field. Mr. Page has been Chairman of the North Carolina Commission since 1920 and has had charge of the expenditure of $65,000,000 of bond issues placed since. In 1922 more than 800 miles of road were completed in North Carolina and about 1,200 miles of new surfaced road are being built this year. No further facts are necessary to show that Mr. Page is fully qualified to direct the activities of the American Road Builders' Association's great Convention and Show.

Chas. M. Upham, Convention and Show Manager, is also State Highway Engineer of North Carolina and Secretary of the American Association of State Highway Officials. Mr. Upham consented to take charge of the active management of the Convention and Show at the earnest solicitation of the officials of the American Road Builders' Association and the Highway Industries Exhibitors' Association. He has been working continuously for several months on the great mass of details which have to be handled in connection with the Convention and Show. Those who go to Chicago in January will find that Mr. Upham has lived up to his national reputation as an organizer and manager.



Yesterday's Engineers Built for Tomorrow

Yesterday's engineers knew well the value of permanence. Permanence stands out in their every work. Five thousand years ago they tested clay pipe.

It is an interesting fact that modern excavators have unearthed clay pipe in the ancient cities in as good condition as they ever were—proof of the certainty of Vitrified Salt Glazed Clay sewer pipe.

And what today is the demand in a sewer? Permanence! First cost is completely submerged in the low cost of permanence that is insurance against deterioration, the action of acid and alkali, heat, cold and electrolysis, and an assurance of health and long operation.

Specify Vitrified Salt Glazed Clay, the Sanitary Sewer Pipe.

CLAY PRODUCTS ASSOCIATION

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Will do this for YOU

What Other One-Man Machine Could Do It At All?
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A Special Catalog tells the whole story of this great little 3 to 5-ton Road Maintainer and Roller. Your copy is ready

The Austin-Western Road Machinery Company
CHICAGO, ILLINOIS

S. F. Beatty, who has been selected as President of the Highway Industries Exhibitors' Association and therefore will represent their interests in connection with the Road Show, is Vice-President and General Manager of the Austin-Western Road Machinery Company, one of the leading manufacturers of road machinery. He is well fitted to represent the views of his fellow exhibitors, the men whose loyal co-operation has made the Road Show a success in the last few years and who have taken every available inch of space in the Coliseum and adjoining buildings for the 1924 Show.

James H. MacDonald is the man who was one of the founders of the American Road Builders' Association twenty-one years ago and who has always been in the foreground of every movement for good roads since that time. In addition to his interest in the American Road Builders' Association, he has found time to serve as Chairman of the Connecticut Highway Commission and at the present time as a state senator of Connecticut is Chairman of the State Senate Committee on Roads, Bridges and Waterways. To enumerate here all of his activities would require many times the space available. He is Treasurer of the American Road Builders' Association and the fact that he holds that position is assurance that the Convention and Show will be well handled from the point of view of its finances.

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Tar and Asphalt Heaters

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Small Portable Tar and Asphalt Heaters are indispensable as part of the equipment necessary for maintaining roads and streets.

Littleford Heaters are made expressly for this work. Send for Catalogue.

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Wire Fabric Reinforcement for Concrete Roads Ensures Permanence

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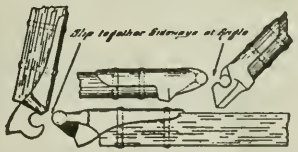
Water Cleaning System, if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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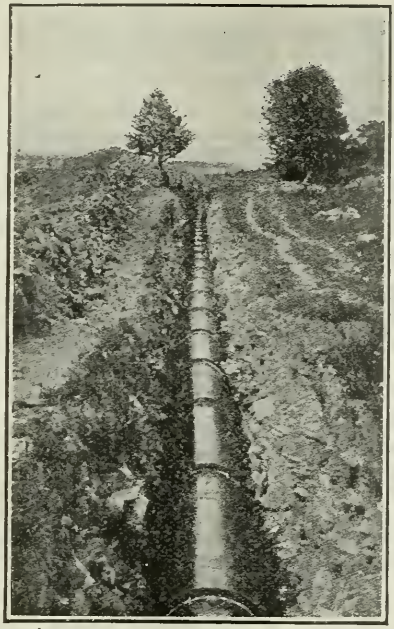

Thirty Inch Pipe Line

Cast Iron Pipe at Syracuse

Showing Bell and Spigot Joints

Few cities are lucky enough to have a supply of pure water available within their limits. Syracuse, N. Y., is no exception to this rule. There the lake from which they obtain their water is located over the hills, twenty miles away.

When their supply line was laid out, a desire to practice true economy led to the installation of a permanent material. U. S. Cast Iron Pipe was purchased and installed. The supply line consists of over nineteen miles of 30-inch pipe and a mile and a half of 42-inch pipe. In spite of the rough country through which this line was laid it has given perfect satisfaction and will serve the community for decades to come.

United States Cast Iron Pipe & Foundry Co.

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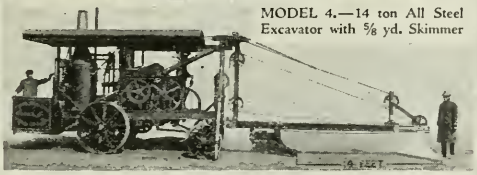

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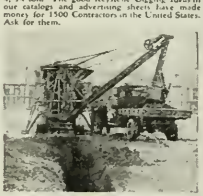

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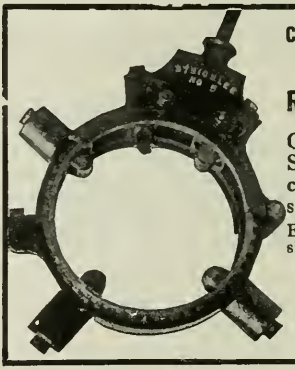

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Vol. LXV. DECEMBER, 1923 No. 6

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EDITORIAL

THE 1924 ROAD SHOW

The "Road Show" is of such great importance to everybody in any way connected with, or interested in, road and street work, that we are devoting several pages of this issue to an announcement of the 1924 Show, the convention program, and the plans, accommodations, etc., which those responsible for the success of the enterprise have provided. This is the one event of the year the worker in the highway field can ill afford to miss.

There are many reasons why thousands of men attend these shows year after year. More information can be acquired, with reference to materials and machinery, by visiting the exhibits at the show than in any other way, and at a minimum expenditure of time and money. To many the greatest appeal of the show is the opportunity it provides to meet old friends we seldom, if ever, see elsewhere, and it enables us to meet face to face those with whom we have corresponded but have never seen. This opportunity to meet people would of itself justify all the work and expense of holding these shows. Those who want to meet the leading highway engineers, contractors and manufacturers should attend the 1924 Road Show.

THE SUPERLATIVE IMPORTANCE OF SOUND HIGHWAY FINANCING

The amount of attention now being devoted to the study of sound highway financing shows that the superlative importance of this subject is appreciated by many. The term "highway" is here intended to have its usual legal meaning which includes city streets and alleys as well as state, county and township roads. The expenditures for highway improvement are now so vast that great injustices may be done in distributing the cost unless the problem is carefully studied and honestly solved.

The subject is very difficult and few, if any, are ready to say that they know just how the problem should be solved. But it is not doubted that equitable solutions will be found as a result of much discussion. Several articles in this issue deal with this subject and more attention will be devoted to it in the future. It is hoped that engineers will apply their trained minds to this problem because of its major importance.

It is comparatively easy to point out some theories that are sound and some that are unsound. The soundness of the gasoline tax, as a road service tax, with proper exemptions for gasoline used in industry and agriculture, has been expounded in these columns on several occasions. This is now regarded as the fairest of all highway taxes, provided only that the proceeds of such taxes are devoted exclusively to highway purposes. There are now 36 states with gasoline tax laws in operation and the measure is popular. About the only remaining opposition comes from motor club officials, who, in the interest of membership renewal and extension, are interested in keeping down the apparent first costs of operating a motor vehicle while disregarding ultimate total costs. Such officials have been able to obstruct the will of the majority of informed people in some cases but such victories are likely to prove short-lived. The people are not "pikers"; they are willing to pay for what they get and the favorable attitude of the great majority of the people toward the gas tax is only one proof of this statement. Gasoline tax legislation is most encouraging to those who favor sound and sane taxation measures. Of course it is indefensible to tax the motorist's gasoline for school, general, or any other purpose except for highway purposes.

A good example of unsound doctrine is the argument that taxes on property alone should be levied to pay for highway construction while taxes on the road user should be only enough to pay for the maintenance of roads. This is an absurd argument; it is easily reduced to an absurdity. In effect it means that the user should pay more for the use of a bad road than for the use of a good road. Since maintenance costs are higher on bad roads than on good ones this amazing doctrine means simply this: the better the road the less the charge for using it. It is astonishing that many men who have achieved affluence and a degree of fame in the automotive world

are seriously advocating that this fallacious form of financing be adopted. Such men in opposing the gasoline tax and in promoting this ludicrous theory of making property pay for construction and the user for maintenance only have surrendered the leadership in this great study. It is distinctly discreditable that their reasoning has been so unsound or so unfair, as the case may be. It is because they are fit to play a more worthy role that they are here so severely criticised. It will do the automotive industry no good to advance insincere or unsound theories in discussing this subject, for faults will quickly be detected and pointed out by men of intelligence in other lines of work than the manufacture and sale of motor cars.

There has, perhaps, been too great a tendency toward generalization in discussing highway finance; not enough attention has been devoted to limiting legal and other local conditions. For example, some say that bond issues should be made to pay the cost of construction of state highways. This statement is often made without any reservations whatever, despite the fact that many important states, Indiana and Wisconsin, for example, cannot bond without first amending the state constitution. It is very doubtful if the Indiana constitution could be amended for this or any other purpose at this time as the residents of this State are rather out of sorts with certain recent amendments to the federal constitution and want to leave our fundamental laws alone for the present.

Even when it is now permissible to bond a state for highway purposes there is a very serious question as to whether or not the cost should be shifted to a later generation by this device. The next generation will have its own problems and it seems unnatural to be shifting the highway liabilities to our children and grandchildren when we are doing all we can in other ways, to make and save assets to leave them. Again, where recourse is had to bonding it is much easier to defend the justice of bonding only to pay for the permanent portion of the road than for the parts that will not outlive the bonds. Rather a good case can be made out for bonding to pay for changes in grade and alignment to save operating costs, for grading and foundation work, and for some bridge work, but it is very difficult to justify, in theory, and as a general proposition, bonding to pay for a wearing surface of compartively short life.

The states of Illinois and Indiana present an instructive contrast in their country road problems. Illinois can bond; Indiana cannot. Ilinois has two types of roads: the highest type of modern highways and the most malevolent mud roads to be found anywhere with the possible exception of Iowa. (An Iowa man recently told the editor that Illinois mud roads have a bottom but that Iowa mud roads are bottomless.) Indiana has an extensive mileage of an intermediate class of roads, namely, gravel and stone roads. Between her modern paved highways and her mud roads Indiana has 30,000 miles of splendid gravel roads reaching every city of any importance in the state. In fact, nearly every highway of any consequence has a good gravelled surface. The extent of these gravel roads may be better appreciated when it is stated that their mileage is six times greater than that of the 7 per cent federal aid system designated for ultimate hard surfacing. Illinois had only mud roads up to a very few years ago. She is now acquiring her primary system at the rate of 1,000 miles a year. After this primary system is finished it will take Illinois many years to construct her secondary system. On the other hand, Indian now has her secondary system and needs only finish her primary system of less than 5,000 miles to have adequate highway development. It will be seen that greater haste is justified in Illinois than in Indiana, in the matter of primary road construction, with a corresponding greater annual expenditure. It may be wise to bond in Illinois, therefore, while the pay-as-you-go plan is clearly right for Indiana. Thus do local conditions influence polices of financing and a dependable financing creed must make due and proper allowance for local conditions.

A subject that is beginning to attract serious study is that of paying for the cost of city pavement reconstruction. This can no longer fairly be charged entirely, or even largely, to abutting property. Then, there is the very knotty question of taxing the motor vehicle for the upkeep of city streets. How shall this be done Shall city and state levy separate taxes or shall the state collect and refund to city and county? If the latter, on what basis shall the refund be made? These are questions requiring much study and their early and proper solution is highly important.

These are the most urgent questions in the whole world of highway affairs. They challenge the best minds of the country.

HOW SHALL WE PAY FOR OUR STREET PAVEMENTS?

Address by John L. Elliott, City Civil Engineer, Indianapolis, Before Second Annual Convention, Allied Motor Commerce (of Ind.)

The type, cost and method of paying for street paving is becoming a more and more important and very intricate problem.

Traffic conditions and requirements are creating more complex situations today in connection with the problems of paying or assessing street improvement costs than ever before and will continue to do so unless some efficient and economical solution is found.

In the beginning of civilization, transportation was not a problem and the early taxpayer was never worried about street or road improvements or assessments. Travel was confined to walking or riding various animals, and roads of those days were for the most part only beaten paths. As desires of man increased, transportation in vehicles increased and with them the necessity for better paths or roads. But even these roads were not expensive and their cost was usually borne by the community.

When the social instinct developed and people congregated in villages and towns, the need for streets or avenues upon which to travel back and forth, in vehicles or otherwise, become obvious. Transportation increased and the old path had to be made into a little better road or street.

The better type of road or street necessarily meant the expenditure of money which in the earlier days, even of this country, was borne by the locality as a whole, and sometimes built the same way. With increasing population, villages became towns, towns grew into cities and the necessity for providing better streets gave rise to the question which confronts us today: "How shall the cost be paid?"

The accepted practice in this country, until recent years, has been to assess the cost of street paving in whole or in part directly against the property abutting the improvement. The number of different methods for assessing this cost was almost as great as the number of states and cities affected, but the fundamental principle of making the abutting property owner pay the bill was always present. In Indiana, until a very few years ago, the cost of all street improvement was assessed against the abutting property or the streets intersecting the street being improved. With the advent and growth of motor transportation, came the necessity for more and better paved streets. Engineers and economists began to realize that to assess the cost of all street improvements against the abutting property owner was unfair and unjust.

Heavy hauling and motor transportation added a new factor to the question. Streets must be built better and resurfaced oftener. In the past, it has been common to have streets in use 40 years or more without resurfacing. In fact, contract was awarded by the City of Indianapolis recently to resurface a street that has been in use 34 years. Such wear cannot and is not expected today from ordinary street paving. Should the abutting property owner be made to pay for new streets at conservatively frequent intervals to facilitate the travel of the city at large?

There is no question but what the original improvement is a benefit to the abutting property; in fact, in the great majority of cases it benefits the property much more than it costs. One well known business man of this City has stated that, in his opinion, original street improvements add five times their cost to the value of the abutting property. Resurfacing, however, cannot be said to add a great amount to the value of the abutting property at least not the entire cost. The question then is: "Who shall pay if not the abutting property owner?" Some will say the logical answer is "Those who are benefited."

The benefits of resurfacing a street are widespread. The abutting property owner naturally is benefited to some extent by having a much better street in front of his property. The commercial interests are benefited because deliveries are quickened with less cost for repairs. The pleasure seeker is benefited since he can ride in greater comfort with less repair bills. In fact, the public generally benefits from resurfacing, therefore the conclusion: the public generally should pay the bill.

There is another method of reasoning used on resurfacing which also has a great deal to recommend it. The original street is improved to give access to the property being improved. The owners of this property, however, do not wear out the improvement they have paid for. When the street must be resurfaced, why not make those who have worn out this street pay the cost of resurfacing? The result of this reasoning naturally means a tax on all vehicles using the streets.

There is much to commend and also to condemn in both these theories. It is our opinion that neither taken alone offers the solution of the question: "Who shall pay?"

Increased traffic is adding another cost on street improvements which demands attention. Narrow streets must be made wider and certain streets must be substantially and expensively paved to provide for heavy hauling. When these improvements come as part of the original cost is it fair to assess the entire cost against the abutting property? Manifestly it is not. Some standard of width and paving should be adopted as the equitable improvement assessable against the abutting property and the remainder paid in the same manner as resurfacing.

I believe it to be a self-evident proposition that the best method to collect any assessment or tax is that which causes the least irritation to the taxpayer. With this in mind, I would recommend that the question, "Who shall pay?" be answered as follows:

The cost of the original street improvement of a standard width and type should be paid entirely by the abutting property owners. Any expenditure made necessary by providing a wider or better pavement should be paid by the city from a street improvement and repair fund which shall be a continuing fund, collected in a manner to be described later.

Resurfacing costs should be paid entirely by the city from the above mentioned fund. Charging the entire cost of resurfacing against the city is more economical than assessing a percentage against the abutting property as it places the entire burden of maintenance on the city and is an incentive to better repairs. It also permits the resurfacing of such portions of streets as need resurfacing. Whereas assessing any portion of the cost against the abutting property necessitates the resurfacing of entire sections of streets and from curb to curb.

The fund previously mentioned should also be used for the maintenance and repair of all improved streets and should be provided in part by direct taxation and collected as other taxes and in part by taxes on the users of streets. This tax should be a part of the registration fee collected by the state and should be returned to the city in proportion to the number of automobiles and trucks registered from that city. A certain portion of the gasoline tax collected by the state should be returned to offset the money expended in repairs. All fees collected for permits to cut streets and all money collected for repairing of cuts should also go to this fund. The fund should be a continuing fund from year to year so that any unexpended balance will be available the next year.

The whole question of assessing the cost of street improvements must be viewed with justice and fairness to all concerned. Co-operating between the property owner and the vehicle owner means better streets and and better business.

THE DESIGN AND OPERATION OF SEWAGE PUMPING STATIONS

By C. S. Timanus, of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

While the art of pumping water has been practiced for hundreds of years, the lifting of sewage by mechanical means was little used until comparatively a few years ago. The progress in the design of machinery for handling sewage began with the universal adoption of the water carriage system of sewage disposal, and has since kept pace with the widespread demand for better sanitary conditions.

There has been much discussion of the proper method of pumping sewage. First cost, reliability, economy of operation and sanitary features are the important topics of interest and discussion.

Reliability and Sanitary Features

Reliability is perhaps the most important of these elements, while the sanitary features of a plant rank as a close second. Indeed, the two elements are very intimately related. An unreliable plant may easily become the cause of unsanitary conditions and a nuisance. On the other hand, a plant may be dependable—always capable of handling all the inflowing sewage—but, nevertheless, a nuisance on account of unsanitary receiving wells, trash racks or bar screens.

Cost

Secondary in importance to the reliability and sanitary features of a plant come its first cost and economy of operation. Theoretically, the allowable first cost depends on the economy of operation, and operating economy in turn depends on labor costs, power costs and maintenance charges, any one of which may become the controlling or dominating factor of the entire operating cost. Power costs are easily calculated, but labor costs and maintenance charges are more difficult to estimate, and require

experience and good judgment. It is the designing engineer's duty to consider such factors carefully and arrive at the true operating economy of the proposed plant.

Large and Small Stations

Consideration of the general elements of design leads to the division of sewage pumping stations into two general groups, which for want of a better classification may be designated as large stations and small stations. In general, stations handling in excess of 1,000 g. p. m. of sewage or storm water may be classified as large stations. These stations are characterized by large valves and water passages, large equipment and, where screens are necessary, by elaborate mechanism for cleaning screens and disposing of screenings. Trouble from stoppages is rare because pumping equipment with large clearances and valve passages may easily be provided. Motor driven centrifugal pumps are very often used, and in many cases stations are equipped with oil or gas engine driven generators to provide emergency power. Excellent examples of large stations are the Calumet, Des Plaines and Evanston stations of the Chicago Sanitary District, and the older stations at New Orleans.

Small stations, those pumping sanitary sewage and small quantities of storm water, are much more numerous than large plants, and because they are more often encountered in general design practice, and because they offer problems as perplexing and as difficult of solution as the large stations, the detailed discussion in this paper has been limited to stations of this type.

Preliminary Investigations

Before any station can be intelligently designed, careful preliminary investigations are necessary. If the station is to be located on an established system, actual gaugings of the sewage flowing should, if possible, be made. Studies should be continued long enough to determine the daily maximum flows and the weekly maximums. A careful inspection of the system should be made, and the number of roof connections and cellar drains discharging into the lines noted. If the lines are old there is a possibility of ground water infiltration, which may reach considerable proportions in wet weather. Low places, where perforated manhole covers act as storm water catch basins, should be investigated and recorded.

Infiltration

An attempt should be made to eliminate all unnecessary infiltration, roof water or storm flow. If this is impossible, pumping equipment must be provided to handle abnormal peak loads. Pumping unnecessary quantities of water only adds to the cost of operation and to the first cost of the station for equipment which is used only a part of the time. Where conditions are such as will permit, storm flows of approximately six times dry weather flows may be bypassed around the station. This will depend, however, on whether there is a convenient point of discharge below the station and whether the discharge of such flows would be considered a nuisance.

Capacity

Stations built to serve new districts where sewer mains and laterals are installed coincident with the construction of the station, should be designed to serve the ultimate future needs of the district. Additional equipment can be installed as the district grows. In such a district it is possible practically to eliminate the effect of storm water periods by seeing that pipe joints are carefully made, that manholes are properly set, and that roof connections are not allowed. . Grades of sewer mains and laterals can be made steep enough to dispense with flush tanks. The normal flow may be estimated approximately 50 gals. per capita per day, or 250 to 400 gals. per sewer connection per day. Peak loads may be estimated at 175 to 200 per cent of normal flows.

Selection of Equipment

Having determined the capacity of the station, the next step is the selection of proper equipment. This can not be done, however, without a clear understanding of the limitations of certain types of equipment when subjected to this kind of service. Very frequently flows as small as 100 to 500 g. p. m. are encountered in the design of these plants. Pumps designed to handle clear water in such small quantities usually have inlet and discharge openings of 2 to 4 ins., while the clearances through the impeller of centrifugal pumps or the valves of a plunger pump are much smaller. Experience indicates that clearances through any device for pumping sewage should not be less than 5 and preferably 6 ins., unless the equipment is protected by screens or trash racks of some sort. Self-cleaning screens are out of the question because of the cost, while small bar or wire screens are always a nuisance from the sanitary standpoint, and very often

can not be tolerated. The attention necessary to care for them properly is large and the consequent maintenance costs are abnormally high.

Sewage Ejectors

These limitations of the ordinary types of pumping equipment have led to the development of the pneumatic or air lift systems using sewage ejectors, as they are commonly known. The sewage ejector is nothing more than a cast iron or sheet steel pot, into which the sewage flows through large inlet pipes. When the pot is full a float operated valve is opened, admitting air under pressure on top of the sewage, which is thus forced out into the discharge main. Check valves on both the inlet and outlet sides prevent backflows from the discharge main when the pot is filling ,and backflow into the inlet line when the pot is discharging. Air for the operation of the ejectors is supplied by means of air compressor units, which may be steam, electric motor or gas engine driven. Usually on municipal installations, electric motor drive is employed, with gas engine or gasoline motor standby units provided.

Either horizontal or vertical compressors may be used. In the small sizes air-cooled or hopper-cooled types may be had. For the larger sizes, circulating water must be employed.

Types of Motors

Where compressors are electric motor driven, several types of motor may be used, operated through remote control apparatus actuated by pressure regulators connected to the air receiver. If the motor is less than 5 H. P. it may be thrown directly across the line by means of a magnetic switch. Where motors are thrown directly on the line they should either be oversize or capable of exerting a large starting torque or starting effort. Otherwise an unloader should be used on the compressor, which will allow the motor to come up to speed before receiving its load. For any type motor over 5 H. P., automatic starters, which allow the motors to come up to speed gradually, should be employed. Motors can be connected to compressors either by gearing, silent chain, or belt. Short belt and idler pulley drive is usually employed, although some types of chain drive are as flexible as the belt drive and as positive as gearing.

Ejector installations lend themselves to a number of housing schemes. The ejector pots themselves may be placed in underground wells or pits detached and even removed some distance from the compressor stations. However, it is perhaps best, even though more costly, to build the ejector pit inside the station proper. By this arrangement all the machinery is easily accessible and well protected. It is highly inadvisable to house motor driven compressor units in underground structures. In severe climates some method of heating the station should be provided.

Pumping Station Advantages

From the standpoint of first cost, the ejector type station is at a disadvantage when compared with a pumping station employing centrifugal pumps and screens. It is difficult to give percentage comparisons, inasmuch as conditions of installations vary somewhat, but it is probably true that the ejector station wil lcost at least 25 per cent more than the station using centrifugal pumps. The cost of operating the ejector station will, however, in many cases compare very favorably with the pump station. This is true in spite of the fact that the power costs are higher for the ejectors. The station efficiency of the ejector plant will be in the neighborhood of 25 to 30 per cent, while that of the pump station will be between 40 and 55 per cent. The cost of an operator must, however, be charged against the pump station, while ejector stations, on the other hand, require very little attention other than the oiling of moving parts occasionally. One man looks after a number of the stations, or where there is only one station it is only necessary to delegate a man from some other city department to make the occasional inspections and oiling necessary. It is because of the fact that the ejector requires little care and attention, coupled with the fact that it possesses excellent sanitary features, that this type of sewage pumping station has proved itself satisfactory.

Trash Pumps

Where it is necessary to handle quantities of sewage in excess of 500 gal. per minute, the ejector station, while still capable of the service, is not so well adapted as a centrifugal pump station, using the Wood Trash Pump. The Wood Trash Pump differs from the ordinary clear water centrifugal pump in that there are large clearances through the pump which allow the passage of debris or trash which would stop the ordinary centrifugal pump. The vanes are constructed in such a manner as to take up

very little of the circumference of the impeller. There are no sharp points or edges upon which trash, rags or paper might catch, and the curvature of the ends is such as to tend to oust such rags or trash as might engage the vanes.

It is claimed for these pumps that they will allow the passage of a solid sphere of the next lower standard size than the pump, i. e., an 8-in. pump will pass a 6-in. sphere or anything which will flow around a 6-in. pipe elbow.

Control

These pumps are built in either horizontal or vertical types, suitable for most any type of drive. Motors are usually employed, however, and may be either direct current or alternating current. Several methods of control may be provided, but the most popular and the simplest is a float-operated switch actuating an automatic starter. The installation of these pumps is no different from that of any type of clear water pump running automatically. A closed well should be provided and pumps so set as to remain always primed. No screens are necessary on plants equipped with these pumps in sizes larger than 6-in. and consequently the station may be made entirely automatic, requiring no more attention than is required for the ejector station.

The efficiency of the Wood Trash Pump is remarkable, approximating that of the ordinary clear water pump. In the larger sizes a test efficiency of 76 per cent has been attained. The efficiency curve is flat, which offers an opportunity for a considerable variation in head without a large change in efficiency.

In recapitulation and conclusion, these points are emphasized: First, the designer of the small sewage pumping station should be very careful in determining the capacity of the proposed station. Second, he should pay special attention to the sanitary features of his plant. Third, he should be fully aware of the limitations of ordinary clear water pumping equipment when employed in this service. Fourth, for flows under 500 g.p.m. no class of equipment is as satisfactory as the pneumatic sewage ejector. Fifth, for flows of over 500 g.p.m. the Wood Trash Pump offers the best solution of the problem.

The foregoing paper by Mr. Timanus was presented at the Fifth Sewage Disposal Conference at Iowa State College, Ames, Iowa.

BRIEF OF ANNUAL MEETING OF ADVISORY BOARD ON HIGHWAY RESEARCH

The Advisory Board on Highway Research, Engineering Division of the National Research Council, met in Washington, D. C., Nov. 8-9, 1923. A. N. Johnson, chairman of the Executive Committee, presided.

Highway engineering and transportation, or the construction and operation of the highway, is not a theoretical or academic subject, but a vital part of our economic and social life. We are spending each year in this country a billion dollars for road construction, while the demand for more high-type roads is insistent and growing. The investment in motor vehicles in round figures is 10 billion dollars, and the annual operating cost of these vehicles is some six or eight billion dollars more. With an investment and annual expenditure of this magnitude, can anyone doubt the need of a practical study of the economics of highway construction and operation? This is the field of highway research.

Thomas H. MacDonald, Chief, U. S. Bureau of Public Roads, in an address, "Objectives of Highway Research," emphasized the thought that the highway engineer, besides a day's work faithfully done, must also engage in research work if he would advance his profession and himself.

Charles M. Upham, State Highway Engineer of North Carolina, in an illustrated talk, "Research Program of North Carolina Highway Commission," stressed the need of practical highway research and its translation into road service for the highway user.

The chairmen of the various research committees reported results and progress obtained in the past year and outlined a program of research for the coming year. The reports will be later published at length in the Proceedings of the Advisory Board. A brief digest of the committee reports, containing information of practical value, is given.

Committee on Structural Design of Highways

Chairman, A. T. Goldbeck, U. S. Bureau of Public Roads.

1. *Subgrade*

A layer of sand, cinders, broken stone, or other porous material will prevent capillary moisture from rising to the

overlying road surface. Tile drains are inefficient in removing capillary moisture.

Results of tensile, shear, and compression strength tests on various soils are given in detail in the report.

A "Field Test for Moisture Equivalent," described in detail in the report, gives a tentative criterion for classifying soils as to their suitability for use as a subgrade.

The addition of 5 per cent of hydrated lime or Portland cement to a soil materially reduces the expansion and contraction of the soil. The admixture of sand with the soil has a similar effect.

Heat treatment of the soil requires a temperature of 600 degs. C. to effect a physical change in the soil. At this temperature the clay content is reduced and the sand content increased, resulting in a reduction of the expansion and contraction of the soil.

Drainage ditches are effective only in removing water in excess of the capillary moisture.

There is every evidence to show that temperature has a very marked influence on the water capacity of soils. The colder the soils, the greater the capacity for holding moisture.

Some materials, such as many types of clays, take up considerable quantities of moisture when it is available and expand in volume, while other materials, like sand, gravel, crushed slag, etc., take up only enough moisture to coat the surfaces of the particles and show little expansion.

When macadam or broken stone bases are used over a heavy clay subgrade it often happens that the clay is forced up through the voids in the stone and renders the broken stone layer much less resistant to loads. A light blanket of sand or similar material interposed between the subgrade and the broken stone is effective in preventing the clay from working up through the overlying stone layer.

The soil itself does not expand on freezing, but the expansion occurs in the moisture alone.

2. *Sand Clay, Top Soil and Semi-Gravel Roads*

For successful roads, there is required:

(a) Graded mixtures capable of making a dense mass on consolidation. The best mixes run as low as 20 per cent porosity.

(b) Uniformity of composition secured by thorough mixing.

(c) Heavy compacting from the bottom upward. This is usually done by traffic. There is need for a type of multiple rim roller to hasten and unify the degree of compactness imparted to these roads during construction.

(d) The mixtures must have a liberal amount of coarse material above No. 60 sieve.

(e) Depth of compacted surface should be 10-12 ins. Crown of ¼ in. per foot is sufficient.

3. *Forces on Pavements Resulting from Traffic*

Preliminary tests of the Bureau of Public Roads indicate that when driving over a typical concrete road at high speed with a fully loaded 2-ton truck, we may expect impact values of approximately 20,000 lbs., or over five times the static load on one rear wheel. With a fully loaded 5-ton truck at high speed, we may expect forces of 35,000 lbs. to 40,000 lbs., or over four times the static load on one rear wheel. If a downward movement of the loaded truck body occurs at the same instant as an impact, the two forces are of course additive, and the results may be double the impact. Therefore, under certain bad surface conditions a total force of 40,000 to 60,000 lbs. may be obtained at each rear truck wheel.

The semi-monolithic brick pavements showed less resistance to impact than the monolithic brick pavements with same depth of concrete base (Bates Road). The monolithic brick pavements showed about 18 per cent less resistance to impact than the plain concrete slab of equal depth. These results obtained by the Bureau of Public Roads on slabs 7 ft. square.

The observed deflections of concrete pavements are very nearly directly proportional to the load (Pittsburg Test Road).

The resistance to structural failure of plain concrete pavement slabs of uniform thickness and laid on a uniform subgrade, when subjected to highway traffic loads, is in proportion to the square of the thickness of the slab (Bates Road Test).

Structural failure normally first appears at corners caused by open cracks or joints. The edges of ordinary pavement slabs should be strengthened so

that the corners and the edge of pavement may have approximately the same resistance to structural failure as the interior portion of slab.

The endurance limit of concrete, when subjected to repeated tensile stresses, may safely be taken as not less than 50 per cent of the modulus of rupture of the material (Bates Road Test).

Committee on Character and Use of Road Materials

Chairman, H. S. Mattimore, Pennsylvania Highway Commission.

The strength of Portland cement concrete varies with the amount of actual solid material present in a given volume, and with the relative parts of this volume that are cement and aggregate.

Other conditions being the same, the strength of concrete varies with the amount of mixing water. Grading of the aggregate has a decided effect upon the amount of water that may be used to yield a workable mixture. This emphasizes the benefit of using well graded aggregates.

There is need for research to develop methods of making more uniform concrete upon a large scale in practice, in order to apply the information already available on the design of concrete mixtures.

Outline of tentative program of research in bituminous mixtures.

Committee on Highway Finance

Chairman, J. G. McKay, U. S. Bureau of Public Roads.

A budget system as a definite part of the highway program is essential. Under the budget system a fixed amount of highway revenue is necessary for the construction of a relatively fixed amount of new mileage each year, the balance of the revenue being used for maintenance, reconstruction and betterments.

Any plan of state or county highway financing should conform as closely as local conditions permit to the fundamental rules which govern the raising of public revenue: (1) An equitable distribution of the burden between the contributing sources according to the benefit derived from the improvement and the differences in the ability to pay for the improvement. (2) Provide a definite amount of highway revenue yearly. This implies the highway budget system.

It should be emphasized that the use of credit does not solve the problem of distributing the highway costs between the several sources of revenue. The same sources of revenue which finance highway improvements when credit is not used must also provide the revenue to meet highway bonds when funds are borrowed.

The larger the amount of permanent highway investment in existence in a state, the less the real need for the use of credit in financing the improvements. A second factor in determining whether to use present sources of revenue or make use of credit depends upon the wealth of a state and the ability to produce highway revenue from this wealth without unduly burdening it.

The problem of highway finance resolves itself largely into the question of a just distribution between the burden on land or real property, and the burden on the highway user.

Real property taxation for highway purposes bears too large a portion of the burden of highway expenditures, producing, in a survey of four Wisconsin counties, from 55 to 70 per cent of the total highway revenue. The major portion of the burden on real property is due to local and county taxation of real property for highway purposes. In the four Wisconsin counties the local units produce 47.49 per cent; county units, 41.81, and the state 10.70 per cent of the real property revenue for highway expenditures.

The highway user, whose demand for highway service is largely responsible for highway improvements, should assume a larger part of the burden in the form of motor vehicle tax and gasoline tax.

Committee on Economic Theory of Highway Improvement

Chairman, T. R. Agg, Iowa State College.

The following projects have been completed and results published or are in process of publication:

"Truck Performance on Grades" (Michigan Highway Commission and University of Michigan).

"Rolling Resistance and Related Characteristics of Roadway Surfaces" (Bureau of Public Roads, Iowa Highway Commission, Iowa Engineering Experiment Station).

"Economics of Highway Grades" (Iowa Engineering Experiment Station and Iowa State Highway Commission).

"Quartermaster Tractive Resistance of Roads Research."

Committee on Highway Traffic Analysis

Chairman, G. E. Hamlin, Connecticut Highway Commission.

A traffic census will give information pertaining only to the traffic using the

highway at the time the census is taken. A highway transport survey is to determine the probable amount and character of the future traffic which will use a given highway during the lives of its several component parts. No state has extensively taken up the highway transport survey.

After an extended highway traffic census it is recommended that additional counts be taken at critical periods of the year in succeeding years, from which, after a number of counts have been taken, curves of natural increase can be plotted, from which can be roughly determined an estimate of increased traffic for a reasonable period of years. This estimate should also include the curve of increase of motor vehicle registration, which can be determined at the present time in every state.

The value of an extended traffic survey in determining the allocation of construction and maintenance funds in the development of a highway system is unquestioned. Such traffic survey, however, should be utilized for type and strength of surface, rather than for location of expenditures, inasmuch as the development of new territory within a state is as much a demand upon the expenditure of highway funds as the taking care of traffic already developed.

The personnel requires a certain amount of special training although courtesy has been found to be the largest asset. A special sign at the census station giving the reason for the questioning is the greatest factor in reducing the time required to pass a car or truck through the station.

An outline of traffic survey methods and cost in Connecticut is given.

A self-recording traffic counting and weighing device, to operate at minimum cost, is being developed.

A traffic census must include enough detail and be taken over an extended period of time so as to determine the seasonal traffic which varies greatly in certain parts of the country and which is a maintenance rather than a construction problem. The construction type must be based on the heaviest travel rather than on average or seasonal travel. A determination should also include the effect of slow moving vehicles upon the general situation and the consideration of the possibility of legislation which will remove such vehicles to secondary roads during high peaks of traffic to avoid congestion.

Committee on Maintenance of Roads

Chairman W. H. Root, Iowa Highway Commission.

Corrugations form in all gravel roads when the traffic becomes excessive, probably 500 or 600 vehicles per day. Their formation is in no way dependent upon construction or maintenance methods. Corrugations are most apt to occur on flat grades. They are caused by displacement of the material due to the spin of the drive wheels, and by impact of the wheels both front and rear after a bounce. Dragging with heavy equipment after a rain is a temporary corrective.

Use of calcium chloride and refined tar in dust prevention and surface treatment of gravel roads outlined.

Maintenance of gravel road surfaces with a mulch treatment of gravel is giving good results on light traffic roads. The treatment consists of keeping a light application of loose, clean gravel, up to ¾-in. size, on the surface of the road.

A light color of the filler used for joints and cracks in concrete pavement is no longer considered esential. Experiments are being conducted with various grades of tar and asphalt for fillers.

Every state should adopt a distinctive symbol for its route markers.

Warning signs should be uniform in all states and should not be used except where necessity is obvious. Shape, color, size and location recommended in report.

All advertising signs should be forbidden on the highway right-of-way.

Expenditures by the states, through their maintenance organizations, shall be classified in their annual reports for purposes of uniformity and comparison, as follows: 1. Maintenance Administration. 2. Maintenance Proper. 3. Additions and Betterments. 4. Parks, Camping Grounds, and Roadside Beautification. The last three classifications shall be charged to a specific section of road.

Additions and Betterments shall include expenditures for the increased permanent value of the road to accommodate traffic. This will include the cost of: 1. Increased width of surface or roadbed. 2. Increased depth of wearing surface over any previous maximum depth. 3. New guard rails. 4. New walls. 5. New drainage structures and water courses. 6. New subdrains. 7. Improving grades, alignment, and vision.

Maintenance costs should be reduced to a ton-mile unit for comparison between types of road surfaces.

The U. S. Bureau of Standards gave progress reports on "Research on Tires" and "Tests of Braking and Stopping Conditions of Motor Vehicles." Dr. H. M. Westergaard, University of Illinois, discussed "Mechanics of Stiff Road Slabs." These and other papers and the discussion will be published in the Proceedings.

Dean Anson Marston, of the American Association of Land Grant Colleges, was unable to attend the meeting. In a paper, read for him, he pledged the continued co-operation of the land grant colleges and engineering experiment stations of the United States.

An extract from the report of Director W. K. Hatt follows:

"In the three years much progress has been made in quickening the will to research, in mobilizing the energies of research agencies and in assembling the data necessary for judgment upon questions of highway planning, construction and operation.

"It may be said with a large degree of confidence that at present a well trained and experienced highway engineer, in possession of available data, can select a type of highway suitable to the conditions of climate and traffic of a given situation, can specify the materials and design the section with a reasonable certainty that it will withstand the specified conditions of service.

"It is true that the communication of these data to engineers in general has not kept pace with the accumulation of the data nor has a working organization for the process of analyzing the data and translating the discovered principles for the use of engineers been adequately provided. The Advisory Board has published bulletins of information on existing research projects, on apapratus for research and the director has written many occasional papers. Its Research Committees have summarized progress. Much remains to be done, however, in unlocking the stored up data in the files of the state highway commissions which are now such active agencies in highway research."

RESEARCH PROGRAM OF NORTH CAROLINA HIGHWAY COMMISSION AND ITS RESULTS

By Charles M. Upham, State Highway Engineer, Raleigh, N. C.

The immediate necessity in research work is the practical application of our present knowledge already obtained by research. We now have vast funds of knowledge that have been obtained through research, but the benefits obtained by the present knowledge have not been developed to the extent that would be commensurate with the labor and money expended. The reason for this is the non-application of the knowledge already supplied. Therefore, our problem is not necessarily one of research alone, but also a problem of application.

Probably there is nothing new in the fact that North Carolina has a research program, because every state, county or municipality that is carrying on the construction of highways has, to a degree, a research program. In addition to this, laboratories scattered throughout the United States are also carrying on various researches. A survey by the Highway Research Committee disclosed the fact that many hundred programs were in operation. Some of them, of course, were duplicates, but the fact was disclosed that a great amount of research was being carried on.

Practical Application of Research Findings

The difficulties of a research program are numerous, but probably no greater problem exists than keeping research within practical limits and carrying it on in such a manner that when completed, it may have a practical application and serve as a step in working out economically some of the highway problems. Already a vast amount of research knowledge has been acquired and this information is written into bulletins and distributed but, unfortunately, many times the bulletins do not do the most good, because they do not reach the proper persons, nor are they written in a manner that will serve the busy official that generally organizes programs, and so our research problems are still unsolved because the important step of the application of highway research work has not been thoroughly taken care of.

The Problem of Research

The problem of research seems to divide itself into two minor problems—research of the problem itself and the application of the research results. This application is such an important step that it could almost be considered a problem of research in itself, and no doubt a proper study of this application could well afford to be given. We find that a great amount of research has been carried on, but as yet a vast amount of the

knowledge gained has not been applied to road building and, consequently, the economical value of the research has been lost.

In North Carolina every attempt has been made immediately to apply the results of research. Almost every step in construction is being studied in detail and when anything of value is discovered, it is immediately applied to construction on a large scale.

Road Service

Not only does research include problems that may be carried on by the laboratory, but it includes transportation problems—problems that will ultimately render road service to the user of the highway. The great research problem is to render road service to the public by the use of which transportation may be more economically carried on. These major problems of transportation and road service are, of course, influenced by other problems, such as the problems of construction, maintenance and operation. In all highway research there should be constantly kept in mind the question of how the results of this research can influence the road service rendered to the user of the highway.

Sand Asphalt Pavement

One great research that has recently been carried on has been the development of progressive type roads. In certain localities in North Carolina there is practically no road building material, with the exception of sand. The problem in this instance was to devise some means whereby these large quantities of sand could be used in road construction. The answer came in the construction of the sand asphalt road, which is made up of approximately 90 per cent of sand and 10 per cent of asphalt. These roads may be constructed in either single or double track, according to the needs of the traffic and are generally constructed 4½ ins. in depth. This method of construction affords a moderately low-cost road, which renders very satisfactory road service to the locality. It is not expected that this type of road would stand up under a large amount of heavy truck traffic, but it is a development road and is satisfactorily rendering road service to the user of the highway. This road, of course, is the result of laboratory research, but it is in particular the result of the proper application of research work.

Marl Rock Base

In another locality in North Carolina, where there is no stone for road aggregate, there is an underlying strata of marl rock. This rock is the result of a large deposit of shells. While this deposit must have at some time been on the seashore, at the present time it is some 8 or 10 miles from the ocean and is about 4 or 5 ft. below the swamp. This marl rock is being quarried and crushed and is furnishing an excellent base for a sand asphalt surface. While the details of this construction were taken from earlier road work, still the use of this marl rock means the practical application of investigative research.

Subgrade

The studies of subgrades have been demanding considerable attention during the past few years, but there seems, even at this time, to be a lack of properly applying the findings. It has already been determined that different soils are affected differently by the varying amounts of moisture. In some cases, however, no attempt is made in the selection of soils for subgrade purposes. In many localities a proper selection of soils will not only furnish an ideal subgrade but will serve as a road, a subgrade highway, to take traffic up as high as 400 vehicles a day. These selected soil roads may be maintained for a period and then used as an excellent subgrade for the next higher step in construction.

Capillarity

Recent research has brought to light considerable information regarding the capillarity of different soils. For a long period it seemed as though a poor subgrade or a clay condition might be best remedied by the construction of a Telford foundation. Now it appears that the Telford foundation served as a drain to carry away the free water but was of very little, if any, value in taking care of the capillary moisture. Recent experiments have shown that a layer of material similar to sand is a more effective means of cutting off capillary moisture. This explains how excellent results have been obtained in the construction of macadam roads on dry subgrades where the screenings have been spread on the subgrade. It also explains the wonderful results that have been obtained by bituminous roads when they were constructed on a gravel and sand foundation.

Research has shown that capillary moisture is not cut off as well by coarse

material as it is by ordinary sand. The answer to this probably is due to the fact that in the coarse sandy material the high capillary subgrade material finds its way into the interstices of the coarse material and the capillary tubes of the high capillary subgrade material continue to act through the interstices of this coarse material; whereas, in the sandy material, the high capillary subgrade material is excluded and the capillary tubes do not act as freely in the sand. This is a very important point and one that can be taken advantage of and very easily and economically applied to road work on a big scale much more so than is commonly done.

Veneer Surface

Another important application of research work is in the construction of stone veneer on earth roads. In the South there is an exceptionally large mileage of earth roads, consisting mainly of the sand clay, topsoil and gravel types. The bearing power of these roads is high and the strength is great. There is still a great problem surrounding these roads, since they offer very little resistance to abrasion, and with them the dust problem as well. Thus the problem in this particular instance is to secure some means of protecting the surface against abrasion and to abate the dust nuisance. This seems to have been found in the stone veneer surface where the quality of an asphalt wearing surface is combined with the strength of an earth road.

There have been several attempts made in applying bituminous material to earth roads. These in general have been unsuccessful, due to the fact that if the bituminous material was sufficiently light to penetrate the surface, it had no binding power or strength whatever, and if the bituminous material was sufficiently heavy to have a binding value, it would congeal on the surface and peel off, due to the fact that a dust mat was formed underneath the bituminous material.

This problem seems to have been answered by applying a layer of stone of approximately 3 ins. in size to the earth road surface and rolling it partly into the surface, after the surface has been scarified or loosened, and then penetrating the top of the stone with bituminous material of a consistency to give sufficient strength to hold the material in place and afford resistance to wear. This bituminous material is then covered with proper sized stone and rolled and opened to traffic. The stone is held in place from below by the earth road and has become an integral part of it. The bituminous material holds the stone in place on the surface and affords a resistance to traffic abrasion. Thus we have a combination of the strength of an earth road and the wearing qualities of an asphalt pavement. This again is the practical application of research work.

Hard Surface Types—Coarse Aggregate

Another problem in construction is the ideal construction of hard surfaced roads. Much laboratory research has determined that the aggregates must be of certain qualities and properly graded. Recent experiments in concrete work have shown that much depends upon the grading of the aggregate. While the early tests indicate that a large aggregate gives a higher strength value, long time tests seem to show that the aggregates below an inch and a half give higher strength values. While in this instance we have a research giving one result, still it is impossible to apply this in its entirety, due to the fact that the present arrangement of crushing plants and aggregate production machinery do not furnish economically an aggregate that gives the highest ultimate strength. Therefore the proper application of this research is in a compromise approaching the ideal conditions.

Core Drill

At the present time considerable research is being carried on attempting to correlate the laboratory tests of materials to the final product as found in the pavement by the core drill. At the present time it seems that there are so many variable factors that it is impossible to control all of them and as a consequence, the results of the final product vary considerably.

Not only have studies been made of the coarse aggregate, but a new test for fine aggregate has been developed, which seems to permit a larger percentage of fine aggregate to be used, or, in other words, aggregate that would be condemned under the standard test, can now be used with safety. This test consists essentially of testing the aggregates directly and in the final product in compression and transversely and not in tension as is done in many of the present day standards.

Investigations in cement also show that this material varies considerably

and the final strength of the road depends primarily upon the quality of the cement used. It seems that individual brands may vary considerably. This may not be only a question of manufacture, but also one of storage and handling until the cement is used.

Surface Finish

Possibly there is not a single demand on a pavement as great as the impact of traffic. Impact depends entirely upon the smoothness of the road surface; therefore, considerable study has been given to obtaining smooth surfaces. This has been put into practice by devising various means of finishing the surface.

In the question of concrete, it is found that the smoothness of the surface depends on many factors, some of the chief ones being the consistency of the concrete as well as the character of the subgrade. This subgrade, after being wet by the concrete, expands or contracts and the green concrete in the road surface does the same. Various types of check templates are being used to check the surface before it sets up so that it may be corrected while still plastic. In the case of the bituminous roads test boards and straight edges are used during construction and then after the road has been opened to traffic it is again tested. Recently experiments have been carried on with the vialog, which is an instrument recently devised for measuring unevenness of road surfaces.

There has been much discussion relative to the detailed construction and maintenance research problem, but probably the greatest problem and the most immediate need is a solution of the proper methods for taking the research work that has already been done and applying it practically. This leads us to the problem of organization and personnel and the varying results obtained in the work show the influencing factor that personnel has on any undertaking. Research with construction and maintenance problems deals with definite qualities, but research, organization and personnel deal with varying factors of the human mind and thus are more difficult to solve. The proper and economical application of research work is also research along the lines of personnel and organization. It is useless to spend time, money and effort in carrying on research unless the results are applying in a way that will more economically solve our problem, and in order that the facts may be used to the greatest advantage, they must be presented to the proper persons in a way that is definite, concise and easily understandable.

The foregoing paper by Mr. Upham was presented at the recent annual convention of the American Association of State Highway Officials.

RECENT OBSERVATIONS ON SEWAGE DISPOSAL WORKS IN EUROPE

By George W. Fuller, Consulting Engineer, 170 Broadway, New York, N. Y.

When visiting a few sewage disposal projects in Europe recently, my attention was directed to several features which may be of interest, as follows:

1. Adoption of the activated sludge process in England goes forward steadily. Plans are being adopted and plants are being built both with the air diffusion of oxidation and mixing and with mechanical circulation arrangements.

2. At Reading, England, a town of 60,000 population, the air diffusion method has been adopted and the works are now under construction by Activated Sludge, Limited. The sludge will be dried on 8 acres of untreated city refuse. The Hanley plant with the same style of aeration is now in service. The surplus sludge is pumped back into the preliminary sedimentation tank, whence the mixed product is pressed and sent to the dump.

3. At Sheffield, the mechanical circulation arrangement of Haworth with paddle wheels has been in service for three years in treating about 500,000 gals. of sewage daily after it has been passed through preliminary sedimentation tanks holding about one hour's flow. By the end of the year the Sheffield works will have in service two new units, each rated at a capacity of 1.25 million gallons of dry weather flow daily. Mr. Haworth informs me that this type of installation of the activated sludge process has been adopted at places where works are either in operation or under construction for projects of daily capacities as follows:

Sheffield (2) 15,000,000 gals. and 500,000 gals.
Wakefield (2 schemes) 5,000,000 gals. and 400,000 gals.
Rotherham, 2,000,000 gals.
Mansfield, 500,000 gals.
East Ham, 500,000 gals.
Barnsley, 500,000 gals.
Stockport, 5,000,000 gals.

Taunton, 750,000 gals.
Burnley, 500,000 gals.
Burley-in-Wharfedale, 500,000 gals.
Chesterfield, 2,000,000 gals.
Paris, 500,000 gals.
All quantities are in Imperial gallons.

4. The Bury device, patented by Bolton and sold by the Ames Crosta Sanitary Engineering Co., Ltd., has been adopted by Mr. Watson at Birmingham. This plant has a daily capacity of 2.5 million gallons daily and is provided with aerating channels holding 140,000 gals. or a retention period of about one hour during which the velocity flow is 1 ft. per sec. for the sewage which has previously passed through sedimentation tanks holding about 12 hours' dry weather flow. The purpose of this plant is to remove colloidal matter, lessen the odor at the nozzles of the sprinkler beds to which the settled effluent of the activated sludge plant will be applied, and also to increase materially the rate of filtration of existing beds. The activated sludge after sedimentation in Dortmund tanks will pass through reaeration chambers holding about 6 hours' flow and where the aeration will also be provided by the device with its revolving aprons attached to a motor-driven vertical shaft. From the results of the tests made last year, it is expected that about 95 per cent of the suspended (organic) matter of the sludge will disappear through wet combustion and the surplus not needed for return to the influent of the main aeration tanks will be sent to the sludge digestion basins.

5. On Oct. 1, 1923, the official opening of the new low level sewage pumping station occurred at Leeds, where the main treatment will be provided by tanks and sprinkler beds 30 acres in area and of which 10 to 15 acres are completed. Another large sprinkling filter plant on which the construction was begun during the past year is at Bradford, where there will be 60 acres of 6-ft. beds of fine coal.

6. The London County Council, at its Crossness works, is conducting comparative tests in tanks holding about 24,000 gals. to show the relative merits of the air diffusion and of mechanical circulation arrangements of the Haworth type. The tests which include one set with the sewage aerated by flowing from a tank through a spray jet, are being conducted with London sewage which has previously been subjected to sedimentation for about 25 minutes.

7. There is not yet adequate information to show which is the best way of conducting the activated sludge method as regards aeration by air diffusion or by either of the two well-known types of mechanical circulation. It will take considerable information to develop needed comparative data to throw needed light on the economics of the problem and particularly upon flexibility and reliability of the several devices in meeting the varying conditions encountered on a working scale. The need of such information is realized in England, but in view of the fact that each of the three arrangements seems to serve its purpose under good management, there is no great speed being shown in the development of adequate comparable data which ought to be secured jointly from an engineering, chemical and biological viewpoint, having due regard for the economics of the situation, under practical working conditions.

8. Stream Line Filters have been very recently proposed for dewatering sludge, but otherwise there have been no new developments except the Reading scheme as above mentioned and those described by the writer in articles appearing in Engineering News-Record, February, 1923.

9. The early summer of 1923 was very dry in England. Some use of chemicals was understood to have been made at the plain sedimentation works of the London County Council and conditions at Glasgow have become such that substantial quantities of chemicals are added there to precipitate finely divided suspended matter, not removed by plain sedimentation.

10. Centrifuges are being used at Frankfort for dewatering sludge to a spadable condition during about 6 months of the year, during the cropping season, while during the colder season of the year the sludge is applied directly to farmlands to save the cost of centrifuging.

11. At Berlin the sewage farms are being operated as usual. Due to the annexation of numerous suburbs giving the city now a population of over 4 million people, there have been abandoned a number of small plants in the suburbs both for water supply and sewage treatment. It is even proposed to abandon the large sprinkling filter beds at Stahnsdorf during the coming winter in order to utilize the coal of which the beds are built.

The foregoing matter was presented by Mr. Fuller at the recent annual convention of the American Society for Municipal Improvements.

DESIGN AND CONSTRUCTION OF HIGHWAY LIFT BRIDGE OVER MYSTIC RIVER AT MYSTIC, CONN.

By Wm. G. Grove, American Bridge Co., 30 Church St., New York, N. Y.

The bridge carrying the New York and Boston Post Road over the arm of Long Island Sound at Mystic, Connecticut, having become inadequate for the heavy modern interurban electric car and auto-truck service, the State of Connecticut decided about 1918 to replace the bridge with a new structure designed to meet the needs of present and future traffic on this very important interstate highway.

Description of Old Bridge

Several bridges were built over the Mystic River at this site during the last century, the third bridge being built about 1886. This structure was removed in 1904 and replaced by a through riveted truss swing span 151 ft. center to center end bearings, with a clear roadway of 21 ft. This type of movable span provided for two navigation channels each 49 ft. in width. It was designed for a single car track with a roadway and sidewalk either side. Short approach spans connected each end of the draw span with the abutments. This bridge gave satisfactory service until the introduction of heavy interurban cars and large auto trucks made it imperative to provide for a bridge of great capacity.

Considerations Governing the Type of New Bridge

The river at this point being a navigable stream and therefore coming under the control of the United States War Department, it was stipulated that the new bridge should be of such type as would provide for a channel of 75 ft. clear width and 135 ft. clear height. The State of Connecticut specified that the bridge should have a clear roadway of 33 ft., with provision for a single car track on the center line of the bridge, and that there should be a sidewalk 5 ft. clear width on each side of the bridge. This necessitated a bridge of 48 ft. 6 in. center to center of handrailings.

Various types of movable bridges were considered for this opening. The relatively great height of required channel clearance compared to the length of span, excluded the vertical lift type. The extreme width of the bridge, practically 50 ft. overall, would require a swing span of at least 210 ft. center to center of end wedges if the bridge was symmetrical with both arms of equal length. Buildings at both ends of the bridge extended up to and in some corners in front of the abutments so that a symmetrical swing span would extend about 25 ft. over the west abutment, thus making a bobtail swing span the only solution of this type.

The elimination of the swing and vertical lift necessitated the use of a bascule, and after careful consideration, and comparative estimates, it was decided to adopt the "Brown Balance Beam" type, a new type, patented in 1918, of which the bridge described is the first example.

Description of New Bridge

With a clear channel width of 75 ft., the main lift was made a through plate girder span 84 ft. 8 in. center to center end bearings, resting on piers 88 ft. center to center. The tower span is a through plate girder, 23 ft. center to center bearings, located west of the bascule span. To complete the crossing there are two through plate girder approach spans one 33 ft. 6 ins. center to center bearings and one 67 ft. center to center of bearings at the east and west ends of the bridge respectively.

The main girders on all spans are 36 ft. 6 ins. apart with floor beam and stringer floor construction.

The lift span is counterbalanced by two concrete weights, one at each side of the bridge, carried by balance beams in the form of trusses which rest on trunnions at the tops of the tower bents. These trusses are about 60 ft. long and their forward ends are connected with the plate girders of the lift span by non-rigid suspenders consisting of eye bars and short links having double sets of pivots at the span end. Stops are suitably placed on the upped chords of the lift span girders to contact at the proper time with the short links and so change the point of rotation of the suspenders from one set of pivots to the other. This system of multiple pivots is the important distinguishing feature of the New Brown type. By means of this construction, the angular motion of the counterweights is less than the angular motion of the lift span, and hence the span may be raised to a vertical position without the counterweight passing between the tower bents, and therefore the weights,

tower bents, and lift span girders may all lie in the same plane. The concrete counterweights at the rear end of the trusses are provided with the usual pockets for adjusting blocks.

The specifications called for the span to be opened to the 90 deg. position in 90 seconds. The main source of power is 3 phase, 60 cycle, alternating current delivered to the bridge site at 220 volts. It is there transformed down to 220 volts and carried to two 36 h. p. induction motors located under the sidewalks, one motor on each side of the bridge. From each motor the power is transmitted to a worm gear unit having a ratio of 20 to 1. From the worm wheel the power is further transmitted by 3 reductions to the rear end of a large bull wheel section located above the floor and in the plane of the tower bent and main girder. The forward end of the bull wheel section is connected by links to an operating trunnion on the main bascule girder. The two independent machinery reductions are connected by a small transverse shaft extending across the bridge.

The bull wheel operation eliminates the necessity for end locks and the worm gear units avoid the use of high speed spur gearing and hence the operation of the bridge is remarkably smooth and noiseless.

The motors are provided with solenoid brakes on the motor shafts connected so as to be ordinarily set and released when current is applied to the first point on the controller. By this arrangement, should the current for any reason be suddenly cut off, the brakes will automatically act to hold the bridge in the position it occupied at the time of cut off. In addition to the solenoid brakes there are provided emergency air brakes so arranged as to be applied in case the main brakes failed to operate. These emergency brakes are controlled by air at 70 lbs. pressure, supplied from a reservoir, which is filled when necessary by an electric air compressor.

At the center of the transverse shaft connecting the gearing across the bridge there is a bevel gear fixed on the shaft. A removable pinion and capstan afford means to operate the bridge by hand should the electric current fail from any cause.

Removal of Old Swing Span

The State built a temporary wooden trestle to the north of the bridge site, and about June, 1921, diverted all highway traffic, except the electric cars, over this trestle. The electric line was cut; on the west end of the bridge cars were operated between Mystic and Groton, while on the east end they operated between Mystic and Stonington. The removal of the old draw span was then done by the state of Connecticut during June and July, 1921.

Substructure

The work on the substructure consisted in removing the old piers and building 3 new piers and 2 abutments. Work was started in July, 1921, and was practically completed in February, 1922.

Construction of New Steel

The contract for the steel superstructure and machinery, with floor, rails, paving, operator's house ready for traffic, was awarded to the American Bridge Company in August, 1921. Drawings were made at the Edge Moor plant (now discontinued), and the steel work was fabricated at the Pencoyd plant. Nothing unusual was experienced in the shop, the character of the shop work being similar to other lift bridges of the bascule type.

The design of the bridge was well developed on the consulting engineer's plans, so that the drawing room work was largely in adapting these plans to shop standards.

Erection

As there were no proper facilities for a dock near the railroad station at Mystic, which would have necessitated a short haul from the station to the bridge site, it was decided to erect the steelwork by lighter. The steelwork was therefore consigned to New London and loaded on one lighter of 200 tons capacity and one barge of 300 tons capacity. The heaviest pieces to lift were the two main bascule girders, each weighing approximately 25 tons. The lighter, which was the property of the T. A. Scott Company, had a 96-ft. boom with a capacity of 50 tons.

The steelwork finally reached New London the latter part of April, 1922, and was loaded on the lighter and barge and towed the 10 miles east on Long Island Sound to Mystic. The steelwork for the two approach spans and the tower spans was then placed by the lighter and then the steel towers themselves erected.

After the main trunnion bearings at the tops of the tower were properly aligned with the main bascule girder trunnions, the two counterweight trusses were lifted into the horizontal position, the forward ends resting on a temporary wooden bent, and the rear ends guyed back by ropes.

The question that had been given considerable study was whether the concrete

counterweight should be placed with the bascule span in the open or closed position. There were advantages and disadvantages in either method.

By erecting in open position, the counterweight would be placed at practically roadway level, with simplicity of form work, particularly at the pockets. These pockets, which were left open for the adjustable blocks, were in open position, at the top of the counterweight. It was, however, more difficult to place and hold the main girders in upright position and then erect the balance of the steel of the bascule span. This, however, as well as the placing of the main portion of the wood floor could have been accomplished, but it was practically impossible to lay the wood block wearing surface properly on the roadway and the reinforced concrete sidewalk slab with the span open from 75 deg. to 90 deg.

On the other hand, the erection of the span in closed position would facilitate the complete erection of this span, including the wood floor, wood blocks, sidewalk concrete and hand railing. This would mean, however, that the counterweight would have to be placed in the high position, requiring staging to support the concrete forms.

A modification of this scheme was considered, whereby the steelwork of the bascule span would be erected in the closed position. The span would then be raised by block and tackles and the wood floor placed in open position. The counterweight could then be poured in low position, using a small amount of staging. The span would then be hauled down by a line attached to the toe end, and the wood block and sidewalk slab finally placed with the span down.

This modification was, however, not carried out, and after mature consideration it was decided that greater speed and safety could be obtained by erecting the entire bascule span closed and the counterweight in high position.

The west approach girder was designed to take one half the weight of the concrete counterweight when the latter was in open position, in which position it was about 8 ft. from the pier. In raised position the counterweight was about 24 ft. from the pier, so that the girder was not strong enough to support the counterweight in this position with the additional framework and staging required. To remedy this some wire guys or ties were attached to the top of the counterweight truss to support a slab formed by pouring about 2 ft. of concrete and allowing this to set. The additional weight of the concrete was then carried by the counterweight truss. This method proved to be entirely satisfactory.

While the concrete counterweight was being placed, the steelwork for the bascule span was erected in closed position and the wood floor, wood blocks and concrete sidewalk placed thereon. Simultaneously the machinery was erected and the shafting lined up. The electrical equipment was installed and the transformers placed in position near the operator's house.

The structure was then practically finished and ready for the balance tests, which were made on July 13, 1922. These proved to be satisfactory, and the Highway Commissioner then formally declared the bridge open for traffic, which event was appropriately celebrated by the towns of Mystic, Groton and Stonington.

A special feature in connection with the field work was the boring and framing of as much of the lumber as possible at the mill. The steel erectors are averse to handling creosoted lumber, and on this bridge it was decided to relieve them of a large portion of this work. The spiking pieces, curb guards, ties and other miscellaneous lumber were bored and framed before creosoting, so that very little field work was necessary on this lumber, the principal field work being boring where steelwork or other boxed lumber was used as a templet. The lumber was also given marks similar to shipping marks on the steelwork. The erection department was well pleased with this method of handling the lumber, as it not only saved field expense and time, but also relieved the erectors of an uncongenial task.

Conclusion

The bascule and tower spans were of the design patented by T. E. Brown. The approach spans were designed by the State Highway Department of Connecticut. The substructure work was done by the J. E. Fitzgerald Co. The structural steel superstructure was fabricated by the American Bridge Company at Pencoyd plant, and erected by the Eastern Division erecting department. The electrical equipment was installed by the American Bridge Company. The concrete counterweight was placed by the C. A. Sibley Co. The wood block pavement was furnished by the Jennison-Wright Company and placed by the Standard Engineering Co.

THE COST OF ADEQUATE STREET LIGHTING

By L. A. S. Wood, Manager Street Lighting Section, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

The advantages to a city of an improved street-lighting system are thoroughly appreciated by the public, but the cost of adequate street lighting is not so well understood. This is a subject of the utmost importance to municipal officials, and a clear analysis of the whole situation is necessary before the cost of adequate street lighting can be determined.

The conditions governing the cost of adequate street lighting are the same with municipally operated street-lighting plants as with a public utility service, and, in either case, the public must ultimately pay the interest on the investment and a fair depreciation on the equipment, or the system cannot be operated satisfactorily. We cannot get "something for nothing," and if a city wishes to possess an adequate street-lighting system, it should be prepared to pay adequate rates to obtain it.

Misleading Conditions

The public, unfortunately, has been to some extent misled as to the cost of street lighting, due to the fact that in the early days of electricity, street-lighting rates were not always based on the actual cost of the service, but were often quoted in consideration of some concessions in connection with the granting of the franchise. Furthermore, street-lighting rates have remained practically constant for many years, and we are paying today little more per capita for street lighting than we paid 20 or 30 years ago. In view of the enormous increase in the costs of labor and material in recent years, this is manifestly unfair and we are led to ask, how is the service maintained under these conditions?

Advances in the Art of Lighting

Public utility companies and municipal street- lighting plants have been able to maintain street-lighting service with existing rates and appropriations, because of the developments in street-lighting units which have increased the efficiency of the units and reduced the costs of labor and maintenance. The introduction of the Mazda C lamp and the consequent reduction in trimming costs was coincident with the rapid increase in the cost of labor and material. As a result of this development, the arc lamp, which up until 1913 was the standard unit for street lighting, was rapidly replaced by the Mazda C lamp, and street-lighting services were maintained without increases in the rates.

From the foregoing remarks, it is evident that the sale of street-lighting service at existing rates is not profitable and consequently is not an attractive business for the central station. Superficial observers might conclude that a low rate for street lighting would be advantageous to a city, but unless the business is profitable, the central station not only has no incentive to improve the service, but it has no funds available for this purpose. The result of this condition is a poorly maintained street-lighting system with dirty glassware and inefficient service.

It would be logical to assume that if the investment required for adequate street lighting returned a fair interest, the public utility companies would be energetic advocates of improved street lighting, whereas, at the present time, they are in general not interested in advocating improvements requiring an investment which might have to be covered by an inadequate rate.

Lighting to Fit Rates

An interesting side-light was thrown on this situation at the recent Annual Convention of the Illuminating Engineering Society, at which eleven authorities on street-lighting practice presented their solutions of a typical street-lighting problem. Copies of the problem were sent to central stations, consulting and manufacturing engineers, and a tabulation of the intensities of illumination recommended shows that those suggested by the central station engineers were, on the whole, lower than the intensities recommended by the other engineers. In the discussion it developed that the central station experts had been guided in their recommendations by what they believed, from previous experience, a city would be willing to pay for a street-lighting system, and not by what they thought would be adequate to take care of modern requirements. It is my belief that this attitude on the part of central stations will not be changed until municipal officials and the public realize that to obtain adequate street lighting, adequate rates must be established.

Adequate Rates

What is an adequate rate for street lighting? This is a difficult question to answer, because the rate will depend largely on the locality and size of the city under consideration. In general, however, an adequate rate for street lighting is a rate which will return a fair interest on the investment required for an ade-

quate street-lighting system, and one which will provide for the efficient maintenance of the system, and a reasonable depreciation on the equipment.

Unfortunately, while provision is occasionally made for an adequate street-lighting system, municipalities often overlook the importance of establishing a rate for the service which will provide for adequate maintenance. The efficiency and appearance of a street-lighting system depreciates rapidly unless glassware is cleaned at regular intervals, and it is quite evident that unless an adequate rate sufficient to cover adequate maintenance is established, little effort will be made by the public utility company for a growth in what is an unprofitable load. To keep the street-lighting losses as low as possible, the central station with an inadequate rate for street-lighting service, will be apt to neglect the equipment which, in consequence, will fail to operate at normal efficiency.

"Outages"

As a legacy from the days of the arc lamp, city administrations generally keep a record of "outages" in order to collect penalties imposed under the terms of the street-lighting contract, although, with modern street-lighting equipment, such outages are comparatively few. "Semi outages" caused by dirty glassware or blackened lamps generally pass unobserved, even though such "outages" are a greater factor in the efficiency and appearance of a street-lighting system than the actual outages. Central stations and municipal plants cannot be expected to take care of such conditions unless adequate rates are established.

It is generally conceded that the cost per capita for an adequate street-lighting system should not be less than one dollar, and yet, an investigation into this subject disclosed the fact that there were only nine states in the Union in which the per capita expenditures of municipalities for street lighting exceeded 90 cts, and only four where the expenditures were more than one dollar. At the time the investigation was made, it was found that the average expenditure for the whole of the United States was approximately 71 cts. per capita. (Report of the Lighting Sales Bureau, National Electric Light Association, 1921.)

Budgets for Lighting Are Small

Street-lighting budgets form a small portion of total municipal expenditures; and, while there have been large increases in practically all departmental expenditures, which in some cases have nearly doubled in the past ten years, there have been only slight increases in the street-lighting budgets. An investigation of municipal finances was recently made to determine "just where the tax dollar goes," and whether a fair proportion is expended on street lighting. This disclosed the rather startling fact that while 21 cts. of each dollar "goes" for protection (police, fire, etc.,) only 3.4 cts. "goes" for street lighting.

The cost of adequate street-lighting systems can often be reduced if the street-lighting improvement schemes are carried out under a comprehensive program co-ordinated with and included in city zoning plans. In designing ornamental street-lighting installations, the most important consideration is to obtain efficient illumination at night at low operating costs, with units which will add to the appearance of the streets by day. The original cost of a street-lighting installation is seldom greater than its cost of operation over a two-year period. Most installations last from ten to fifteen years, so it is plain that a little saved or spent on the original installation becomes an insignificant consideration when compared with the importance of wise planning from the standpoint of maintenance and operating costs.

Patchwork

In past years the usual practice has been to confine street-lighting improvements to limited areas. Just as city planning has in past been almost wholly confined to scattering about the city a few beauty spots, such as civic centers, parks and play-grounds, so has improved street lighting been scattered through the agency of localized improvements carried out as private developments, or in the form of improvement districts. Nearly always the aim has been to boom a restricted area to commercial leadership through the establishment of "White-Ways." The work of so-called improvement districts may be made valuable if regulated under a general improvement plan; but without centralized leadership the result is haphazard patchwork.

Criticisms of Ordinary Lighting

The average run of street lighting throughout the United States is more or less subject to the following criticisms which are approximately in the order of their relative importance:

1. Inadequate illumination.
2. Miscellaneous growth without a

definite relationship to a comprehensive city plan.

3. Inconsistent transitions and gaps in passing from one section to another.

4. A lack of standardization.

5. A lack of classification of streets and an absence of unity of treatment of streets of the same classification.

6. Too many unsightly and disfigured streets, because of insufficient attention to architectural grace and ornamentation.

7. Too much temporary construction instead of building for flexible permanence.

8. Too little application of correlated effort, research and talent.

Correlation with Zoning

A scientifically derived, comprehensive, far-sighted street-lighting program correlated with a city-zoning plan is not easily worked out. It calls for specialized talent in many lines of work, and, in most cases, city officials can profit by bringing into consultation the engineers found in public utility companies, whose success depends largely upon their ability to foresee future requirements and to meet them with a minimum loss in reconstruction. This nation is becoming possessed of may vast cities and most of them—like "Topsy"—"just growed." Our large industrial establishments and other privately owned projects exemplify the economy of employing talented engineers and architects. The city is, of course, more important than any of its contributing factors; and it is unfortunate that some of our cities do not appreciate the necessity of providing sufficient appropriations for this type of personnel.

Constructive Suggestions

In conclusion, I have the following suggestions to offer:

1. That municipal officials seriously consider the cost of adequate street lighting, and assist in the establishment of adequate rates for adequate street lighting.

2. That municipal appropriations for street lighting be increased. It is quite evident that there is room for improvement in this direction.

3. That municipal officials energetically co-operate in the efforts which are being made to include provision for adequate street lighting with city zoning plans.

The foregoing paper was presented at the recent annual convention of the American Society for Municipal Improvements.

DEVELOPMENT OF HIGHWAY BUILDING POLICIES IN NORTH CAROLINA

By H. K. Witherspoon, Publicity Engineer, North Carolina State Highway Commission, Ralcigh, N. C.

Beginning with a small appropriation by the Legislature of 1915 highway building has, within the past few years, come to be one of the leading industries of North Carolina and while a relatively large expenditure of money is necessary to carry on a large road building program, no enterprise in the State is paying, or will in the future pay, larger dividends than the system of good roads which is being built by the State Highway Commision. These benefits are not to be measured in terms of dollars and cents, but rather in the improvement of the social and economic life of the State.

Briefly, the history of road construction under a State Commission began, as stated above, with the appropriation by the Legislature of 1915 of $10,000 and the appointment of a Commission of seven men, including the Governor who acted as chairman. This step was taken in anticipation of the passage of the Federal Aid Road Act which was ratified by Congress in July, 1916. The General Assembly of 1917 enacted further legislation which placed in the hands of the Commission the funds derived from automobile registration but with the stipulation that 70 per cent of the funds was to be expended in the county from which it was collected. This often resulted in the county having the least mileage to maintain receiving the largest allotment while several counties having a larger area, and consequently a larger mileage of roads, but a smaller number of automobiles, received an allotment insufficient to do any worth while maintenance. This unfair division together with the fact that the responsibility for maintenance was left with county officials did not result in efficient results.

With the passage of more far-reaching highway legislation by the General Assembly of 1919, road work in the State took on new life and while this law was far from perfect it marked a decided step forward and its enactment symbolized the beginning of real highway work. Briefly, the law provided for a Commission composed of four members who had entire charge of all construction of roads on the State Highway System; for the working of convicts from the State Prison on highways; to assist the coun-

ties in highway work; and to provide for the expenditure of Federal Aid funds. All revenue from the taxing of automobiles was held by the State Treasurer as the "State Highway Fund" and used for the construction of a system of State highways and to meet the allotments of Federal Aid funds. Counties agreeing to furnish one-fourth the cost of construction of a road in that particular county were given preference in priority of construction. Under this plan one-fourth of the cost of construction was paid by the county; one-fourth from the State Highway funds; and one-half from the Federal Aid fund.

A number of counties took advantage of this opportunity and consequently a number of miles of improved highways was added to the State Highway System. Bunt unfortunately the poorer counties could not avail themselves of this Federal Aid on account of their inability to furnish their own part of the necessary funds. During the two year period that this Commission functioned under the 1919 law approximately 200 miles of improved highways were completed at an approximate cost of $2,464,000, and 650 miles, estimated to cost $9,730,000 were placed under construction. One of the weak points of the 1919 Act was the fact that maintenance work was left in the hands of county officials and this resulted in more or less piecemeal work throughout the State. The State Highway Commission only assisted in a supervisory and co-operative way as far as possible.

Realizing the need for a more extensive road-building program and realizing the necessity for a more adequate system of maintenance, certain far-sighted citizens of the State began an intensive good roads campaign in 1920, which resulted in the passage by the General Assembly of 1921 of the Doughton-Connor-Bowie Act. The purposes of the law are well expressed in Section 2, which reads as follows: "The general purposes of this act are for the State to lay out, take over, establish and construct and assume control of approximately 5,500 miles of hard-surfaced and other dependable highways running to all county seats and to all principal towns, State parks and principal State institutions, and linking up with State Highways of adjoining States and with National Highways into National Forest Reserves by the most practicable routes with special view of development of agriculture, commercial and natural resources of the State, and for the further purpose of permitting the State to assume control of the State Highways, repair, construct, and reconstruct and maintain said highways at the expense of the entire State, and to relieve the counties and cities and towns of the State of this burden." In short, the Act provided for a State Highway Commission consisting of a chairman from the State at large, and for one Commissioner from each of the nine districts into which the State is divided; all engineering work was in charge of a State Highway Engineer appointed by the Commission; funds were provided for construction by the issuance of serial bonds aggregating $50,000,000, and maintenance funds from automobile license fees and from a tax of 1 ct. per gallon on motor vehicle fuel. In addition to these funds, there was allotted to the State under the Federal Aid Act ratified in November, 1921, approximately $1,709, 334 for expenditure in 1922, in connection with an equal amount of State funds.

The General Assembly of 1923 amended the 1921 Act by authorizing an additional bond issue of $15,000,000 and increasing the tax on gasoline from 1 to 3 cts. Section 27 of the law as amended sets forth clearly the method of handling these funds. It reads as follows:

"That for the purpose of carrying out the provisions of this act and provide for the maintenance and construction of the highways contemplated under this act from the funds derived from the various taxes levied under this act, there shall first be set aside the sum of two hundred and fifty thousand dollars ($250,000) annually, or so much thereof as may be necessary to defray the expenses of the State Highway Commission. From the remainder of said taxes there shall then be set aside annually the following, in order named: (a) a sum sufficient to pay the interest upon the first fifty million dollars bonds issued under this act in excess of fifty million dollars and, (b) any interest or sinking fund payments now or hereafter directed to be made therefrom by the General Assembly. The remainder of such fund shall be used by the Highway Commission in the maintenance of the highways taken over under the provision of this act, and to be adopted and designated by the Commission as State highways under the provisions of this act; any part o fthe two hundred and fifty thousand dollars ($250,000) set apart for the expenses of the Commission, and any part of the balance unexpended in the payment of interest on the bonds, shall pass each year under

the control of the Highway Commission and be used by it in the maintenance and construction of the State system of highways herein provided for. All funds derived from the taxes herein levied, or from the sale of the bonds herein provided for, may be used by the Commission in meeting the requirements of the United States Government as to Federal aid: Provided, that all necessary expenses of collecting the said license or registration fees or other State highway funds hereinafter provided for, including clerical assistance, the cost of furnishing number plates and mailing same, and for such blanks, books and other supplies as cannot be furnished by the State printer, shall be paid for monthly by the auditor from the revenue derived from fees or taxes that are collected, said expenses shall be approved by the Governor and Council of State, and shall not in the aggregate exceed 10 per cent of the total amount collected by the Secretary of State under this act."

The average layman cannot grasp the magnitude of this enterprise in which the State is now engaged, nor does he realize the investment that the State is making in a network of modern highways. At the present time road and bridge work under contract and construction totals $39,277,527 and includes a mileage of 1,952 miles. If built in a single stretch, this mileage would extend more than twice across the State following the route of the Central Highway. Approximately 1,022 miles of this total is being hard surfaced at a cost, in round figures, of $29,925,000 while 922 miles are being graded and surfaced with sand clay, topsoil or gravel at a cost of $8,341,000 and bridge work costing $1,011,307.

No road, regardless of its type or how well it is built, will stand up under the wear and tear of traffic unless it is given constant care and attention. This statement is contrary to the belief that existed in years past when, after construction was finished, no thought was given to the upkeep of the road. In this failure to maintain the roads already built the counties are losing much money.

Realization of the necessity for maintenance led to the organization of a highly efficient system of maintenance, one which has wrought wonderful results even in the short time that it has been at work. At the present time there are about 1,200 men engaged in the upkeep of State roads. These men are responsible for the condition of 5,750 miles of road on which they are working daily. Based on a per capita cost per day per person, or based on 1923 statistics, which show that there are 12.4 people to every automobile in North Carolina, brings the cost of keeping the State roads in first class shape to approximately two and two-tenth cents per car per day—an insignificant sum when one considers the lessening of depreciation on the car itself, the wear and tear on tires, the saving of gasoline and oil, and by far the most important, the immense amount of time saved.

One does not have to belong to the older generation to have vivid recollections of the time when North Carolina roads were of such character and in such condition, due to lack of attention, as to be almost impassable during part of the year. The coming of motor cars and the realization of the thinking people of the State that North Carolina, like a human being, was no better than its arteries, have wrought a marvelous change in conditions. Within a few years this State will have as fine a system of all-the-year-round roads as can be found anywhere, the outgrowth of which will be the development to the highest point of the industrial and agricultural resources of North Carolina.

SOME PAVEMENT TYPES AND PRACTICES OF TEXAS CITIES

By W. J. Emmons, Professor of Highway Engineering, Agricultural and Mechanical College of Texas, College Station, Texas.

The question of selection of the type of pavement for a city street is one of considerable complication and one which has disturbed the equanimity of city councils since the first municipal improvement of this nature was inaugurated. Boiled down to its essence, the problem becomes one of finding the pavement which will, like other structures, give the best service for the least cost. Realizing this, the councilman and the property owner, faced for the first time with the necessity for choosing between the multitude of available types throws up his hands and cries, "What is the best kind of pavement?" The answer, however, helps him little, because it is a fact that, while there may be several pavements which will all give approximately equal satisfaction under the conditions at hand, there absolutely is no best type applicable to all cases.

In the comparison of cost data it

should be remembered that many factors enter into the formulation of a bid price. In the absence of competition, prices soar; upon a small job, overhead costs increase, and with local materials conveniently available, lower costs of the constituent aggregates of the pavement should react in favor of the city.

Is Maintenance Clause in Contract Out of Date?

In most cases, the contractor is required, by terms of his agreement with the city, to maintain his pavement in good condition for a period of five years following completion. The theory is that the contractor will do his utmost to guard against the danger of slipshod and careless work. In the days when comparatively little was known of paving materials and methods and when skilled and reputable contractors were scarce, this plan of safeguarding the public's interests was probably justified. At the present, however, the inclusion of the maintenance clause is of doubtful expediency, except perhaps when new and unproved types of pavement are adopted. An incongruous situation is developed when, as is usually the case, the contractor is asked to guarantee the success of work constructed in accordance with the engineer's rather strict specifications, and particularly so when rigid city inspection is also provided to regulate the many details of the work. This latter seems most decidedly to be the more logical and better form of protection, but it certainly must be intelligently applied if satisfactory results may be obtained. A properly laid pavement should require but little outlay for the period of the guarantee and a pavement which does require extensive patching will almost certainly deteriorate at an accelerated rate immediately after the repairs are completed and will be a bad investment. Thus, why not abide by carefully drawn specifications enforced by good inspection and save in first cost the guarantee charge of 5 cts per sq. yd., which the contractor must charge in self-protection?

The durability of the pavement type is a most important factor in its selection. Without exception, everyone of the pavements at present in use in Texas has at some time or other failed to give the service expected of it, but generally such examples of short life are traceable to defects in construction, lack of maintenance or other preventable cause. Occasionally, however, a type may clearly be incapable of withstanding the conditions to which it is subjected. Sheet asphalt and asphaltic concrete will deteriorate rapidly if not subjected to traffic and will behave most satisfactorily when constantly exposed to the action of rubber-tired vehicles. Wood block has repeatedly been found to give the best service under heavy traffic. Bituminous types, such as asphaltic concrete with stone particles in their surfaces unprotected by a bituminous mortar, will, unless the stone is extremely tough, and the traffic very light, show excessive wear after the first few years of use.

Sometimes the harassed taxpayer, when faced with the immediate possibility of a paving assessment inquires regarding the permanent highways of which he has read so much. Perhaps, too, if he is a student of history, he may remark with feeling that the Appian Way, built by the Romans, has lasted for some two thousand odd years, and that the pavements of other ancient peoples are still in existence. These old pavements certainly are in existence, to the credit of the old road builders, but it is true also that they have never been subjected to modern traffic. Also they were built of solid masonry, sometimes several feet thick, and recent rough estimates have developed the fact that it would cost something like $250,000 per mile to reproduce the famous Appian Way under present costs and conditions. No wonder these highways lasted 2,000 years; and no wonder we do not imitate them.

Placed under an environment to which they are suited, however, brick, sheet asphalt, Warrenite-bitulithic, concrete, and the other standard types should give 10 to 25 years of economical service—if properly cared for.

Pavement Characteristics

Several pavement characteristics sometimes listed separately may be included under the term of general suitability. Ease of cleaning, low tractive resistance, non-slipperiness and noiselessness, may be grouped under this head. Possibly the vertical fibre brick with asphalt-filled joints is least easy to clean, and wood block and sheet asphalt may be regarded as the most slippery, especially when damp and slightly dirty. All of the types offer very low resistance to loads hauled over them and are about of equal desirability upon this count.

Wood block and the asphaltic types are the most quiet and concrete is the most noisy.

In these days of intensive street improvements with attendant high prices it behooves the city official to make use of every possible expedient to stretch available funds to the absolute limit consistent with approved practice. Every resource peculiar to his vicinity should be employed to the utmost and, while construction suited to the situation at hand is adopted, it should be borne in mind that certain types may be extravagantly uneconomical. In selecting pavements it is an excellent expedient for the city to look about and locate, if possible, local sources of material supply. A consideration of present freight rates makes the importance of such a find self-evident. The discovery of a gravel deposit may make concrete the logical selection for the city's pavements. A pit of fine sand, entirely unsuited for concrete may be found satisfactory for any one of several asphaltic types. It may be suggested, too, that an asphaltic concrete upon a good gravel base is a type not to be despised for many of the lighter traffic thoroughfares. Many cities are investigating their local resources to marked advantage and it is a practice which should be generally adopted.

Perhaps, also, types other than those backed by strong promotion organizations should sometimes be employed. Of course gravel for outlying sections is commonly laid, but for other situations justifying greater expenditures ordinary water-bound macadam treated periodically with a road oil may give satisfactory service over considerable period. Bituminous macadam, better known, perhaps, as penetration macadam, should also receive attention for smaller towns or for lighter traffic streets of larger towns. Less expensive than the high-class types generally considered as standard, it should nevertheless give long years of service under conditions to which it is adapted.

At the A. & M. College, a street known as Military Walk was paved with asphaltic penetration macadam some 7 or 8 years ago. This pavement is but 5 ins. thick, including both crushed stone foundation and wearing surface, yet with the exception of a single thin application of asphalt and sand, delayed unfortunately, two years too long, it has given the best of service. True, the pavement is subjected to light traffic—perhaps a hundred vehicles a day and four thousand cadets—but many of our city streets lined with fine residences carry little, if any, more.

What has already been said deals with the selection of pavement types based upon engineering principles, but there is one other factor which in many instances outweighs all of these. This factor is promotion. Certain interests, in fact all of those promoting the standard types of paving, repeatedly mentioned heretofore, have expended much time and money in research and in the development of their materials. We owe them a great debt of gratitude for this, for however much they may profit from it financially, the public is benefited to a far greater degree. For instance, the Portland Cement Association has established a research laboratory and employs one of the country's recognized concrete experts and a corps of assistants to find out all there is to know about concrete. The Warren Brothers Company maintains laboratories where not only are developments worked out, but periodic samples from every bitulithic job are tested. The Asphalt Association and the National Paving Brick Manufacturers' Association are doing similar work with the result that new knowledge is constantly becoming available. Reduced to fundamentals, however, street paving is an engineering operation and an attempt has been made in this paper to outline a few points in proof of the claim that the selection of type must be based upon careful analysis of local resources and environments, if economy and service are to result. The engineer is trained to such analysis and he should be allowed to make it uninfluenced by those who, admittedly unskilled in paving matters, may have been thoroughly convinced of the superior merit of a particular type.

The Highway Engineering Division of the A. and M. College frequently receives letters from anxious public officials requesting a frank statement of the relative value of two or more standard types of pavement. The answer in all cases is and must be the same, namely, put your problem in the hands of a competent paving engineer, let him investigate and make the selection in the light of local conditions, for there is no "best type of pavement."

The foregoing discussion is from a

paper presented before the recent annual meeting of the League of Texas Municipalities.

FUTURE OF ZONING AS BASED ON EXPERIENCE TO DATE

By Albert Lee Stephens, Judge Superior Court, President California State Planning Association, Member Planning Board, Los Angeles, Calif.

What have we accomplished in the less than a score of years of legal zoning? First: We have found out that a law which intelligently, reasonably and nonarbitrarily restricts the use of privately owned real property is necessary to protect real property from irreparable damage. Second: We have indisputably established the fact that there is no constitutional inhibition against such a law. That is all there is to it. Nothing is left but application. But application requires knowledge. Knowledge of the law. Knowledge of human nature. Knowledge of your city. It requires patience, stiff backs as distinguished from stiff necks, love of fairness, honesty. With a mayor, board, city attorney, city engineer thus equipped, the house can be put in order and kept in order.

Of course, you shouldn't wait for these conditions to be perfect before starting. No matter how desirable perfection is, you must get along somehow with something less. Without knowledge of law, you immediately run counter to adverse decisions, because you have been unreasonable or arbitrary. It is easy to see that the courts have affirmed this American doctrine of free use of private property in every practical way by holding that interference by law of the free use use of private real property is possible only where such interference can stand the test of reasonableness and is nonarbitrary in character; otherwise, and most fortunately, the owner may use his property as he wills. The courts construe this doctrine along with that other safeguard: "That one may not use his property to the injury of another."

Early Fears Dissipated

From the beginning of my work along these lines, I feared the doctrine I advocated. I feared that once we unmistakenly gained the right to zone, we would become the victims of bureaucratic orders, directed arbitrarily and without regard to principle. One of the Judges, I think of the Supreme Court of Minnesota, once held, in a dissenting opinion, against all zoning, on the ground that such right would mean the sacrifice of personal liberty more dear to us than the benefits to follow the planning of cities.

Rash Enthusiasm

As a rule, professional city planners, laymen and engineers on planning boards, recently convinced of the benefits of city planning, and some few city attorneys I must add, look contemptuously and unstintingly criticise the courts for what they call old fogyism and nonprogressiveness for pointing limitations. These limitations have not only made zoning possible, but have made it desirable under all the circumstances. And these very same decisions have entirely robbed me of the fears I have alluded to.

Holding Back

The most important work from now on, that will fall to city attorneys in planning and zoning work, will be to hold back and with stiff-backed insistence require that the lines of legality already pointed out by the courts and specially equipped lawyers be followed. I don't mean to hold that we have learned all there is to know, nor that we have reached the end of legal advance. I do mean that the impatient, enthusiastic planner will establish some very objectionable set-back lines, unless the city attorney does his part both wisely and courageously.

Knowledge Requisite

Every zoner must have a thorough knowledge of his city. And every commission should be composed of members from the different geographical districts of the city and from every social division thereof. The city planner should begin his work with not only an acquaintance with his own city of the day, but should know its history and stages of development. He also should know other cities. Cities, like men that compose them, are much alike essentially, but very different in particular parts. Your consultant, if a local man, should have a broader vision than the twenty-mile radius from the County Court House. If an imported man, don't go off satisfied with his doing the job. If you do, you will probably have an ill-fitting suit made after the particular fad of your consultant (all specialists are somewhere and in some manner faddists), or you will have a ready-made affair, made to the measure of another town. Notwithstanding these remarks, I am strongly inclined to the imported article. The adage that

"A prophet is not without honor except in his own country" holds good here. Every phase of planning requires patience. The tendency to hurry to get something is one of the greatest dangers.

Early Los Angeles Experience

Well do I remember the first meeting of the Los Angeles Board of 51 citizens. Almost before organization, the chair announced that the secretary would read a communication from the city council. It ran something like this: "Honorable Members Planning Board: We hereby refer to your honorable board, the question of whether or not lot—etc. (describing the lot) shall be zoned for an undertaking establishment." Com. Blank jumps to his feet, "Mr. President, I am personally familiar with the locality mentioned. This board should immediately become a factor in the city government. I move you that the secretary be directed to address the honorable city council, and to say that this board unanimously disapproves of the request to put this lot in the undertaking zone." I was frightened. I arose and under the personal privilege asked how many such communications graced our secretary's desk. There were several. The board, by big majority, was feverishly desirous of doing something right off the bat. I took the lawyer's risk of being accused of causing delay and of being technical, cautioned against precipitous action before formal investigation. Said it was my idea that we should study the whole city thoroughly; take a year at it before we could undertake the responsibilities of zoning, and then take in the whole city or some natural division of it in one comprehensive ordinance. This was not popular doctrine, but I wasn't booed, so I ventured further: Suggested that we may as well here and now adjourn sine die as to become the willing goats, the official passees of the political buck. That evening, after a long fight through the help of others who saw the danger early, the fight was won. Through the motion, if I remember right, of the member who made the first motion, the council's request for zoning help was declined in a diplomatic note.

I relate this merely as an illustration of what will take place in other localities. Our board soon got down to hard work with patience, courage and courtesy to everybody, including Mr. Well Known Citizen who comes in with not only helpful suggestions but with some special favor to ask, and many times the unwilling tool of veiled interests. It should be borne strongly in mind through all preliminary zoning work that public confidence through frank actions and intelligent educational work is absolutely necessary.

Things to Avoid

Zoning experience is now broad enough for us to mark some of the failures and to avoid them. When zoning first developed it was by the piecemeal method. And the continued use of this method by a few cities is zoning's greatest danger. To be legally privileged to go ahead with any use of any lot in town unless or until the legislative body interferes, offends against every tenet of zoning. Proper zoning stabilizes. This method unstabilizes. No man knows whether or not he can use his property until he attempts to use it and after he has financed and planned his improvement. Then the council or board zones his right away. Some other neighborhood of the same character but without an objecting citizen, is used for the same purpose within the law. Here is discrimination with a vengeance. Here also, is the finest field for political reward and punishment. Here also, is the making of graft.

Western cities are growing, changing, forming. Financial interests are looking to our cities from San Diego to Eureka for investment (both inclusive). A group of Eastern financiers, we will say, wish to purchase a city block in San Diego for an industrial enterprise. They select a site; are advised that everything is all right. Preliminary work is done. The money is paid when, what ho! Some citizen petitions the council. Requests a zone ordinance denying the use of this property for the intended use. The intests face a lawsuit and opposition, when they thought they had city co-operation. Do they under these circumstances retain their enthusiasm? Do they buy another site where the process may be repeated on them after disposing of the original one? Do they advise other industries to come to San Diego? The answer is obvious.

Then there is the fellow who rises to remark that Western cities are growing. "Then would you mould your cities according to some board's idea of development, or would you let them freely develop?" I hear him with that conclusive "I've got you" tone, and he surely has if we don't watch out, for that question has in it a danger that we must avoid. And there is no possible alibi if we do not avoid it. At this day, no student of zoning is without knowledge that

zoning must have ample provision for flexibility and change when circumstances indicate its desirability. And without the knowledge that one of the cardinal rules of zoning is that you cannot zone ahead of the tendency already shown by the district development. original kinds of development. It only shall not be spoiled for that kind of use, by allowing another sporadic use that is fatal to it. Anr then there is always that stop, look and listen sign before every city planner or zoner. For no matter how greatly zoning always does add to the beauty of a city, zoning is never based upon aesthetics, but is always related to the public health, safety, morals and general welfare.

The foregoing matter is from an address before the recent annual convention of the League of California Municipalities.

OBSERVATIONS ON REFUSE DISPOSAL IN EUROPE

By George W. Fuller, Consulting Engineer, 170 Broadway, New York, N. Y.

The collection and disposal of solid refuse in England show departures at present from pre-war practice. During the war much attention was given to methods of salvage. But since the fall in prices of salvaged material in 1920 this has been a less conspicuous factor. However, it is effectively carried out at some places, particularly Birmingham, where all activity pertaining to the collection and disposal of solid refuse comes under a Salvage Department. Its superintendnet, Mr. Jas. Jackson, is about midway on a seven years' program of thorough reorganization. For this purpose he carries on his staff ten men who devote themselves solely to organization methods. More will be said beyond about betterments at this city.

British Practice

Cleansing is the name usually applied to the collecting and disposal of solid refuse In some cities it includes the cleaning of catch basins, cleaning and watering of streets, snow removal, etc. The heads are called cleansing superintendents. Some 25 years ago they formed in Great Britain an Institute of Cleansing Superintendents, which publishes monthly the papers and discussions at its Annual Conferences and at meetings of Local Branches.

At the Aberdeen meeting last June were several instructive papers, including a plea for accurate records of quantities and of cost data on a tonnage basis, with essential particulars as to controlling local conditions, by Mr. J. C. Dawes, M. Inst. M. E., who is the chief inspector of public cleansing for the Ministry of Health.

Before any local authority may issue bonds to provide capital for improvements to its arrangements for handling its refuse, it is necessary to apply to the Ministry of Health for its sanction. This is followed by a public hearing which all interested parties are invited to attend, and the approval is forthcoming only after the inspector is satisfied as to the program.

Extent of the Industry

The extent of the public cleansing industry in England and Wales was outlined for 1921 by Mr. Dawes, who gave the urban population as 30,034,385 and the rural population as 7,850,857, a total of 37,885,242. The total annual dry refuse was estimated at 21,270,900 cu. yds. equal to 8,508,384 tons, based on daily yields per 1,000 population for 300 days per year of 1,500 lbs. for urban districts, 2,250 lbs. for mining districts and 1,200 lbs. for rural districts. To handle the refuse requires regularly about 34,000 men, 8,000 horses and 1,600 motor vehicles, besides various equipment at sidings and for transporting the refuse from such. The value of plant and equipment is over 5,000,000 pounds sterling. Public cleansing, including street cleansing and watering, cost for the year 1920-21 12,494,549 pounds, and of this sum the amount for the collection and disposal of solid house and trade waste, including 236,570 pounds for loan charges, was 8,304,549 pounds, of which 464,775 pounds was recovered from the sale of treated refuse, by-products, etc. This total cost of cleansing is about one-seventh of the cost of all municipal services, omitting schools, police and relief of the poor.

Character of Refuse

British refuse, as in all countries, varies considerably, depending chiefly upon the different uses of coal. A representative analysis as estimated by Mr. Dawes, is for ash and fine dust, 45 percent; cinders of all sizes, 35-40 percent; vegetable matter. 5-10 percent; paper and light debris, 4 percent; metals, 1-15 percent; bone, 0.3 percent, and glass, brick and heavy debris, 12 percent. The British collect mixed refuse and do not deal separately with organic matter except as it comes direct from markets. They do not use the American expression of garbage,

as applied to kitchen refuse other than from ranges, but speak of vegetable matter or putrescible matter or organic matter.

During and since the war householders have been urged to lessen their output of refuse. This is largely in the interests of economy, although those in authority clearly recognize that public cleansing is primarily a public health function, and that the ultimate result must be on a higher rather than a lower plane of performance.

Reducing Quantity of Refuse

Suitable publicity is an effective step in lessening the quantity of refuse and in other ways. Its use has been systematically sought in the course of the modernizing of the department at Birmingham, where the collecting wagons have painted on their sides, "Burn More Refuse." The collectors distribute placards to be hung in each kitchen, urging the screening of cinders from ashes and the burning of vegetable refuse in the kitchen fire, as well as the burying in the garden, or the burning of garden refuse. Methods and results are explained by lectures with lantern slides, visits to the disposal works by school children and others are encouraged, and in the central office are window displays exhibiting the activities of the department.

The disposal of the mixed British refuse with its high content of ash and cinders and its low content of organic matter is quite a different undertaking than the disposal of American garbage, practically unmixed with inorganic matter. However, the mixed refuse of some of the Northern, but not Southern cities, in this country is quite like the British product. There is no standard British practice, as the best method of disposal depends upon several local conditions, which frequently vary uuch in different communities. In many districts the selection of the method, within certain limits, is of far less importance than is the efficiency of the management of the department.

In many, if not most, British cities there is real need for better results than are now obtained. Economy is one element of this situation. But it should not be inferred that refuse disposal in Great Britain is free of serious complaint in practically every community; notwithstanding that, within the limits of my observations, the accomplishments there are substantially better than at corresponding cities in America, generally speaking.

There are six methods in quite general use for the disposal of mixed refuse in Great Britain:

1. Tipping or dumping on land where the management is inadequate for securing freedom uniformly from flies, rats, wind-blown papers or objectionable smells, especially from fires which, on account of the large quantity of combustible material in the refuse, sometimes burn for months in spite of efforts to extinguish them.

2. Tipping or dumping on land, in conformity with precautions set forth by the Ministry of Health in its circular of July 26, 1922, as given beyond.

3. Dumping at sea where the barging distance is reasonably short to locations where suitable tides and currents convey the material seaward, and not landward. It is understood that this is practiced only at Southampton and a few northerly cities on the east coast.

4. Burning in high temperature incinerators which the British call destructors, notwithstanding that the burnt refuse leaves perhaps half of its bulk as clinker. In some, but not all places this may be readily disposed of after crushing and screening, for use in road-building or for making concrete, or in some places for brickmaking. Electric current generated at destructors now finds a market through charging the batteries of motor vehicles used in collecting the refuse.

5. Separation from the refuse of the fine dust and ashes by means of revolving screens, and also of the coarser debris, thus leaving the cinders and vegetable matter which are incinerated. This arrangement is briefly explained beyond, as it will be carried out at the new Brook Vale destructor, now approaching completion at Birmingham.

6. Crushing of the mixed refuse, after freeing it of coarse debris, and utilizing the pulverized product as a fertilizer for clay or loam lands. This product is also well suited for filling low lands. The fine material screened from cinders in Method 5 is similarly handled, while in Scotland much refuse is sent to farmers with little or no use of mechanical appliances for its preparation.

Gas Production

The above methods are not intended to be a complete list, but are used as a convenience to expiain the state of the art as I found it. Perhaps mention should be made of the use of refuse by Ashwell and Nesbit, Leicester, to produce gas on the lines of the producer gas plant. Reference certainly should be made to the

work of Mr. W. Weaver, Chief Chemist to the Salvage Department of Birmingham, who read an excellent paper at the Aberdeen Conference, describing his use of the Iwel melters and dryers for making poultry feed or fertilizer from market and slaughter house wastes; purification of oils; de-tinning; analyses of ash, clinker, etc., and various means by which the chemist can aid a Cleansing Department.

Suggested Precautions

Many British refuse dumps are sources of complaint, and to improve matters the Ministry of Health on July 26, 1922, issued "Suggested Precautions," which are given in full below, but subject to review in each case as to figures stated, as follows:

"1. Every person who forms a deposit of filth, dust, ashes or rubbish, of such a nature as is likely to give rise to nuisance, exceeding 100 cu. yds., must, in addition to the observance of any other requirements which are applicable, comply with the following rules:

"(a) The deposit to be made in layers.

"(b) No layer to exceed 6 ft. in depth.

"(c) Each layer to be covered, on all surfaces exposed to the air, with at least 9 in. of earth or other suitable substance; provided that during the formation of any layer not more than 50 to 100 sq. yds. may be left uncovered at any one time.

"(d) No refuse to be left uncovered for more than 72 hours from the time of deposit.

"(e) Sufficient screens or other suitable apparatus to be provided, where necessary, to prevent any paper or other debris from being blown by the wind away from the place of deposit.

"2. Every person who deposits any filth, dust, ashes or rubbish likely to cause a nuisance if deposited in any water must, so far as practicable, avoid its being deposited in water.

"3. Every person who deposits any filth, dust, ashes or rubbish must take all reasonable precautions to prevent the breaking out of fires and the breeding of flies and vermin on or in such deposit.

"4. If the material deposited at any one time consists entirely or mainly of fish, animal or other organic refuse, the person making such deposit must forthwith cover it with earth or other equally suitable substance at least 2 ft. in depth.

"5. Every person who deposits any filth, dust, ashes or rubbish must take all practicable steps to secure that tins or other vessels, or loose debris likely to give rise to nuisance are not deposited in an exposed condition on or about the place of deposit.

"6. Sufficient and competent labor must be provided in connection with the deposit to enable the necessary measures to be taken for the prevention of nuisance.

"7. So far as practicable each layer of refuse which has been laid and covered with soil must be allowed to settle before the next layer is added.

"8. Wherever practicable the person making the deposit must avoid raising the surface of the tip above the general level of the adjoining ground.

"9. All refuse must be disposed of with such dispatch and be so protected during transit as to avoid risk of nuisance."

These precautions are founded on the theory that flies do not penetrate a layer of earth more than about 8 in. thick; that odors of decomposition are controlled by absorption by the 90 percent of inorganic refuse and by the cover of earth; and that "spontaneous combustion" of the refuse is prevented by the earth cover excluding the air needed for combustion.

Filling Quarry Holes

At Bradford I found that the city refuse seemed to be disposed of quite satisfactorily by dumping under careful management in 46 quarry holes scattered about in a city of about 270,000 population. Mr. Call, superintendent, prides himself upon the success with which he has made from former holes attractive parks, playgrounds and gardens, and at a cost for disposal of refuse of only one shilling per ton, besides keeping the collection cost at a low figure on account of the short haul to the numerous tips. At the time of my visit he had started the filling of a large quarry hole adjacent to a large hospital. He takes unusual care to assemble papers and put them in an excavation and cover them so as to prevent their blowing around, and also to put all tins upright and fill them with refuse so as to lessen channels which rats might enter.

Attention is directed to a comparison of the one shilling per ton cost of carefully supervised tipping at Bradford with the ordinary cost of incineration which, of course, varies with the size and arrangement of the destructor plant, but which usually is from 8 to 10 shillings per ton.

Screening

At the new 200-ton Brook Vale Destructor at Birmingham, Mr. Jackson will first remove by screening the ash and dust

which form about 40 per cent of the total refuse. This he will dispose of to farmers whom he expects to pay several shillings per ton. In any event the destructor is freed of 40 per cent of its load, and the most unsituable portion for burning. Operating expenses will thus be spared the cost of say 6 shillings per ton for handling this ash and dust, regardless of the proceeds from its sale. This leaves the destructor to operate upon the cinder and organic matter, which purpose it best serves both from the public health standpoint and as regards power production. Furthermore, the elimination of the dust and ash increases the capacity of the destructor when expressed with reference to the population served by destructor units of a given size.

The arrangement of this plant, which goes into service shortly, is worthy of comment. Briefly, the refuse arrives in motor vehicles on the top of a high ramp, beneath which is a two-story garage for the storage of the vehicles and the charging of their batteries with current produced by the plant. The refuse is tipped into one of three 10-ton concrete hoppers, with sides having steep slopes and at the bottom is a moving metal belt, like a stoker grate, for discharging on to a revolving screen. It is the intent to have not more than 10 shovelfuls at a time on an inclined screen, say 4 ft. in diameter and 10 ft. long, with ⅜-in. openings. The removed ash and dust goes to motor trucks or canal barges, leaving the cinder, which at some places has 10,000 B. T. U. per lb. At the lower end of each screen are several magnets for removing metals from the screened refuse before its discharge on to a moving sorting belt for hand removal of glass, bones and heavy debris. The top of this belt passes under a hood, where it is expected to remove paper by suction. The cells will be hand stoked from the top with material discharged from the sorting belt or from a tip which may be used if it is not desired to screen some portions of the refuse. Clinker will be removed from the rear of the cells. The building, with very complete equipment, has been erected by Heenan & Froude.

The ash and dust has been removed by screening at Glasgow, Sheffield and other places, including two of the older plants at Birmingham, where analyses show it to contain 0.9 nitrogen and 3620 B. T. U., with some potash and phosphoric acid. Analyses elsewhere show that it frequently contains from 0.7 to 0.5 percent or less of nitrogen. However, the Ministry of Agriculture has been investigating refuse and finds that applications of refuse at the rate of 10 tons per acre have proved very useful on heavy clay lands for root crops, cabbage, etc., and that a farmer is justified in paying some money to obtain this result. Compared with 12 shillings per ton for stable manure delivered on the farm, it is stated that town refuse would be worth 6 shillings per ton on the farm, and more if the nitrogen content exceeded 0.6 per cent.

Disposal on Farm Lands

Many of the larger towns of Scotland dispose of much of their refuse for use on clay farm lands, the amount approximating 163,000 tons annually, according to Mr. Asher, Cleansing Superintendent at Perth. At his own city the demand exceeds the supply at 2 shillings per ton f. o. b. at the city siding. He has the rubbish picked from the refuse, which is then allowed to get set, after which it is trenched on top and well watered. This sets up a heat which aids in rotting the paper and vegetable matter. No material is shipped until it has lain at least three months when it has become a black mass, easily handled and not likely to cause serious nuisance.

In England the preparation of refuse for agricultural purposes is being aided at some places by pulverizing it, rather than by screening.

On the Continent

On the continent, destructors are in use at many prominent cities, including Paris, Nancy, Marseilles, Brussels, Rotterdam, Amsterdam, Cologne, Hamburg and Berlin. But at Frankfurt I found that the destructor plant has not been operated since August, 1920, owing to the cost exceeding that of disposal on land. A similar step is being considered at Zurich, where the plant is very fully equipped with mechanical appliances intended to save operating costs.

At Florence I visited the Becarri plant which deals with the mixed refuse of about 100,000 population, together with some stable manure. The refuse is first freed of most of the heavy debris and rubbish by hand picking. There are 154 concrete cells, each about 20 cu. meters capacity, approximately cubical in form, and provided with a ventilating tower in which are trays of earth and sulphate of iron. At the bottom are grids over channels leading to a sump, and in each corner is a vertical iron air duct, with outside connections and also with inside connections with several fillets which ex-

tend horizontally around the inner walls of the cells.

The sorted refuse is placed in a cell, wet with water if need be, and allowed to ferment for about 45 days, including the cooling period. I examined cells where the contents had been fermenting between 10 and 15 days. The interior was very hot, with many patches of white molds, and generally resembled farm yard manure in process of rotting. The final product closely resembles humus, and is screened from coarser particles, some of which are put into a cell for a second time. It is said to be a good fertilizer and to sell for 40 to 50 lira per 100 kilos, or about 10 times the price of stable manure rotted in open pits.

I found no signs of odor or of flies at the cells or in the shed where the fermented product was being screened. There were some flies and smells around piles of unfermented refuse awaiting treatment.

The foregoing paper by Mr. Fuller was presented before the Sanitary Engineering Section of the American Public Health Association at Boston on Oct. 9, 1923.

PRESENT STATUS OF THE STEAM RAILWAYS

By J. D. McCartney, Assistant to the President, Central of Georgia Railway Co., Savannah, Ga.

The transportation problem, though it has many phases, may be summed up in two words, "efficient service." Amplified a bit, that phrase means the securing and maintaining of railroad systems that will, with reasonable promptitude and reasonable safety, carry the commodities from the places of production to the places of use or consumption, at the lowest possible charge for the service.

The record of the railways for the first ten months of 1923 affords ample proof of the competency of railway management. But competency alone is not sufficient to make railroad facilities adequate. If transportation is to keep pace with the business demands of the nation, it must have both competent management and large expenditures of money annually for a long period.

America's capacity for production is measured by America's facilities for transportation. Resources may be inexhaustible, but commodities will not be produced unless they can be moved to the markets of the country. Every branch of industry and commerce has, therefore, keen and vital interest in adequate transportation.

1923 Freight Traffic Greatest in History

The railroads have made good on their pledge of last April to meet the unprecedented demand for transportation this year. Although the amount of freight traffic offered has been the largest in history and much greater than was anticipated, the railroads have moved it promptly and efficiently.

It was predicted last spring that railway freight traffic would reach new high levels during the summer and fall. In preparation for the task of moving this record traffic, the railroads announced a program of expenditures upon additions and betterments to their properties amounting to more than $1,100,000,000 for the year. They set out to reduce the number of freight cars needing repairs to 5 per cent of the total and the number of locomotives needing heavy repairs to 15 per cent of the total. They agreed to lay in surplus stocks of coal during the summer, in order to release equipment for other use later in the year. They agreed to carry forward their construction and maintenance programs to have as much work as possible completed by Sept. 1.

New Equipment

All of these objectives have been substantially attained. For example, between Jan. 1 and Oct. 1 the railroads installed 134,636 new freight cars and 2,963 new locomotives, and on the latter date they had on order, with the deliveries being made daily, 64,601 new freight cars and 1,242 new locomotives. On Oct. 1 the railroads had in reserve 17,663,448 tons of coal, as compared with 6,756,886 tons on Jan. 1..

The surpassing achievement of the year is that a traffic greater than has ever before been known has been moved without interruption or delay. It was anticipated that car loadings would exceed a million cars a week in 9 weeks prior to Oct. 1. In reality, car loadings exceeded the million mark in 15 weeks. In the week immediately prior to October 1 more cars were loaded with freight than ever before in railway history—a total of 1,092,567 cars. Prior to 1923 the record loading was 1,018,539 cars in the week of Oct. 15, 1920. Loadings in the nine months up to Oct. 1, 1923, amounted to 37,308,891 cars, an increase of 19 per cent over the first nine months of 1922, 28 per

cent over the first nine months of 1921, and 10 per cent over the first nine months of 1920. However, it is feared that, even with this unprecedented volume of traffic, the railroads will fail to earn for the year the 5¾ per cent upon their tentative valuation to which the Interstate Commerce Commission has held they are entitled.

A Splendid Performance

The railroads, their employes and their patrons are to be congratulated upon their splendid performance in handling this record traffic. There may be some danger, however, that this great achievement of the railroads will create the false impression that a further increase in railway facilities is not needed. To be able to meet the future demand for transportation as they have met it this year, the railroads must not rest upon their oars; they must continue to extend and improve their facilities. Funds must be obtained to provide the additional facilities necessary to reduce the costs of operation and to enable the railroads to furnish the public adequate transportation at the lowest possible rates. Railway patrons must realize that this requires that railway credit be maintained.

At a previous time when business was on the increase, the development of our railroads was arrested through a loss of credit occasioned by shrunken earnings and the growth of restrictive regulation. It must be remembered that the railroads are owned by something like 800,000 persons, holders of their capital stock. The number of persons who have lent money to the stockholders by purchasing railway bonds and thereby accepting a prior claim upon the earnings of the properties owned by the stockholders is approximately as great as the number of persons owning stock. This makes something more than one and one-half million individuals who have a direct financial interest in railway earnings. All of us have an indirect financial interest, for we are all dependent upon the maintenance of adequate transportation, and adequate transportation can not be maintained without adequate earnings.

Railway Credit Improving

When money must be had for expenditures upon extensions and improvements to the railway plant, and it is not available from earnings, it has to be obtained through the sale of additional securities, either to present stock and bondholders or to other persons. Until the passage of the Transportation Act in 1920, owners of railway securities had not fared very well, and that made it difficult to raise new capital for extensions and improvements. This year, however, railway credit has been improving materially. This has been largely because of the optimistic, forward-looking attitude taken by the railway managements of the country in the face of inadequate earnings. Such an attitude is based largely upon the Transportation Act, which pledges the country to give the railroads a square deal. Thus far railway earnings, while on the mend, have not reached the 5¾ per cent designated by the Interstate Commerce Commission as a fair return. For the thirty-five months under the Transportation Act up to Aug. 1, 1923, railway earnings have been at the annual rate of 3.97 per cent upon their tentative valuation. For the first eight months of 1923, the railroads realized a net operating income of 5.4 per cent upon their tentative valuation, as compared with 4.46 per cent for the first seven months of 1922. With business good and rates unchanged there is hope that the railroads will have a fairly good year, and that hope has served to restore some of the old-time confidence in the security of railway investments. Expenditures upon the railway plant this year will exceed one billion dollars, more than twice the average prevailing in the last several years. About 60 per cent of the sum is being spent for new locomotives and cars; the other 40 per cent is being spent for better and more adequate roadway facilities and structures.

Billion Expended on Railway Plant This Year

The progress that the railroads have made in the improvement of their properties is something to be proud of. It proves that there are men and women in this country who have enough faith in the future of the country and the soundness of its institutions to put up, in one year, around one billion dollars for railway investments despite the meager earnings that the railroads have been allowed to realize. With such confidence as this in the future of the railroads, many of which only a short time ago were taking heavy losses and passing up dividend payments, surely any business which may be suffering temporarily ought to take heart and hold on.

The Threat of Radical Legislation

If it were not for the constant threat

of radical legislation, the country could rely upon a continuance of satisfactory railway service and upon the likelihood of constantly increasing investments being made in extensions and improvements to the railroads. The only thing that can stop the ambitious plans of the railroads to expand in keeping with the growth of the country and of its commerce is the unconstructive legislation of the radicals who are striving with all their might to bring about government ownership of the railroads by making it impossible for the railroads to be operated successfully under private management.

Government ownership of our railroads would be a national disaster. The very fact that the maintenance of good railway transportation means so much to the welfare of the country is reason enough for us not to give up the system of private management that has given us the most efficient, most economical railway transportation in the world.

Our government now has all the power of railway regulation needed to safeguard the interests of the public; government ownership would add nothing in protection, and it would subtract the incentive which now exists under private management to operate the railroads efficiently and economically.

American and Foreign Railways Compared

There are a good many Americans who do not fully realize the tremendous dependence that the United States must place in strong, efficient railroads to maintain the commercial supremacy we have attained. Not until the railroads of other countries are compared with ours and we realize what it means for us to have efficient, economical transportation that has been developed in this country under private management do we see how inextricably the prosperity of the country is bound up with its transportation. Our nation has been extremely fortunate in the development of railway transportation. The remarkable growth that we have had in the lifetime of men still living can be traced directly to the rapidity with which railroads were built and developed, and our prosperity as a nation today is inseparably linked with the maintenance of adequate, efficient transportation.

For the most part our railroads have ignored state lines, and to that extent they have helped to weld us into a united nation. In Europe, on the other hand, most of the railroads were developed as military exigencies required; they ended at the borders of their respective countries, and frequently they were of varying gauges, so that the enemy might not readily use them as a means of invasion. The result has been the fostering of intense nationalism within restricted areas, lack of understanding, commerce of comparatively small proportions, and much of the economic and political trouble to which modern European nations are heir.

In Europe, moreover, there has not been developed to the extent known in this country the practice of territorial specialization in agriculture and manufacturing. In the United States hundreds of miles frequently separate the farm from the packinghouse, factory or mill where farm products are prepared for consumption, and frequently hundreds of miles separate the packinghouse, factory or mill from the consumer who eventually pays for and uses the manufactured product. Transportation has become such a common and dependable thing that it has created a commercial development unlike that at present obtaining in Europe. There are few localities in our country that are self-supporting, and the reason for that is the quality and comparative cheapness of American railway transportation.

Modern transportation is an important part of every form of business. Without it, there could be no farming on the scale that farming is practiced nowadays, no manufacturing in great quantities and at low cost, no distribution of manufactured goods over great areas and to millions of people. Destroy the railroads, and the production of goods would necessarily be limited to the demand of the immediately surrounding territory. It would set the country back nearly one hundred years, for all the development that has occurred since the building of railroads began has gone along with the railroads.

Constructive National Regulation Favored

The railroads frankly invite the fullest inquiry into their methods, resources, earnings, purposes and accomplishments. They have nothing to conceal. They would gladly welcome a universal public understanding of what they are doing and hope to do, how they are doing it, and the difficulties they encounter meanwhile. The railroads favor a system of national regulation. They only stipulate that such regulation should be constructive and not destructive, directive rather

than restrictive. Its aim should be economic, not political supervision.

Faith in the American spirit of the square deal justifies railway management in the determination to provide the service that the country needs, and to make generous plans for the future.

The foregoing address by Mr. McCartney was delivered at the recent annual meeting of the American Society for Municipal Improvements.

ADEQUATE AND EQUITABLE HIGHWAY FINANCING

By R. M. Hubbard, Chairman, State Road Department of Texas, Austin, Tex.

The steadily increasing demand for more and better highways arising from the increase in motorized traffic during the past few years, has resulted in a financial problem so great as to make it imperative that our method of highway financing must be changed and developed if the necessary road support is to be secured and if serious consequences to the motor vehicle industry, to the taxpayers and the community as a whole are to be avoided. Many students of this problem are beginning to appreciate the importance of the situation, and are devoting their time and energy toward securing a correct analysis of the problem and a sane program of finance.

There appear to be two fundamental questions involved. The first relates to the division of the cost of constructing a system of highways as between the present taxpayer and future generations. To what extent shall the roads be paid for by taxes and to what extent by bonds? The second question relates to the division of the cost as between the user of the road and taxpayers in general. A correct answer to these questions would solve the problems.

It is not the purpose of those charged with the duty of completing a connected system of State highways, to raise the necessary funds for this purpose regardless of the source, but they desire to equitably place the burden on the shoulders of those who receive the benefits of the roads, in direct proportion to such benefits. It will require a combination of engineering knowledge and sound economic analysis, coupled with honest, conscientious study to arrive at an accurate and just solution of this problem.

Certainly the present taxpayers want good roads. They want and deserve as many good roads as are economically justifiable. It is obvious that fewer good roads can be built, if the present generation undertakes to pay the entire cost of all roads built, than if a portion of the cost were met by the proceeds of bonds. The question is just how much of the cost should be charged to the future generation, and bonded in a sound defensible program for roads.

We instinctively dislike large public debts—and rightly so. Few of them leave tangible assets. The public must be shown that there is a permanent asset in good roads, well constructed and properly located. Until this is done public temper will not permit large bond issues for road-building purposes. That there is a permanent asset in a well-constructed and properly located road is fast becoming an admitted fact. This being true, then it is right and just for the future generation to bear part of the cost of construction, for it is axiomatic that each generation should pay its way. Granting this, then it is practically, as well as theoretically correct that any debt which the present generation passes on to the next must be adequately covered by sound assets passed on to that generation. Therefore, the question dwindles down to "What part is considered a permanent asset?"

After the road has been completed and our bond money spent, what do we expect? Not a road that will stay intact and resist the heavy motor traffic and bad weather, year in and year out, without being properly maintained. In fact, we expect the surfacing to wear and wash, but we must not overlook the actual increase in value of the permanent investment as the years go by. In other words, the subgrade is better as it becomes compact, the bridges are improved, the hills are cut, the safety factors are strengthened, and railroad crossings eliminated. Use of the road deteriorates the surface, but only enhances the other factors.

Maintenance of the road after construction is requiring a great deal of study on the part of those charged with the duty of constructing and maintaining the highways. It has been suggested, and the writer endorses the suggestion, that the definition of the word maintenance be extended so as to include not only the day-to-day and year-to-year expense of keeping the highway in serviceable condition, but also to include resurfacing whenever needed. In this way the road would never wear out, but would be

turned over to the next generation unimpaired. A road once built to a given standard would be maintained for all time to that standard, each generation assuming the responsibility for maintaining it during the time it used the road. This would make the life of the road indefinitely long, and such a definition, if adhered to, would destroy the argument against long-term bonds. It would seem just that the users of the roads should pay for the cost of maintenance, including resurfacing and new drainage structures.

In this manner we would be able to raise the necessary sums to build an extensive system of highways without unloading on the present generation of general taxpayers the heavy charge of amortizing highway securities in a 15 to 20-year period. Long-term bonds would compel the succeeding generation to pay its part of the cost of the road passed on to them. The success of this theory would require the writing into the law of stringent requirements as to maintenance and a classification of resurfacing as a maintenance charge.

USING DYNAMITE TO CUT OFF CONCRETE PILES

By A. G. Livingston, Bridge Engineer, Delaware State Highway Department, Dover, Del.

Dumorite was successfully and economically used to cut off excess lengths of concrete piles for a bridge across the Smyrna River, now completed by the Delaware State Highway Department.

The piles are 16 ins. square with four ¾-in. round bars at the corners and four ½-in. round bars on the sides; the ¾-in. bars project above the pile and are imbedded in the pile cap.

Test piles were driven to a length of 37 ft. and the length of concrete pile was determined from the test piles. An average length of 28 ft. was selected; it was, however, somewhat in excess of the required length, and it was decided to cut off the extra length by the use of Dumorite.

The corners of the piles were cut away, exposing the reinforcement for a distance of 3 ft. above the cutoff. This corner reinforcement is 2½ ins. from the face of the concrete. A 1¼-in. hole was then drilled into the piles for a distance of from 8 to 10 ins. at a point 3 ft. above the cutoff line and the hole loaded with 6 ounces of Dumorite. Mud was packed in behind the explosive, the proper fuse having been attached before inserting the Dumorite into the drilled hole. The hole was drilled in about 20 minutes. Usually about nine piles were shot simultaneously. The result after shooting left the concrete between the 3-ft. point and the cutoff elevation in such a crumbled condition that it could easily be taken out with a bar or a chisel and hammer, and in no case was the pile injured in any way below the cutoff line. It was only necessary to refire 3 piles in order more thoroughly to break up the concrete to facilitate its removal.

The sum of $30 represents the total cost of powder and the labor of placing it in the holes, about 40 lbs. of Dumorite being used in the operation, while $285 was the cost for compressor, drilling and removing of the pile broken up by the explosive. This, on a unit basis, is slightly less than $6 per pile.

This bridge is composed of four 18-ft. spans on concrete piles, and is the second of its type to be built by the Highway Department of Delaware.

C. D. Buck is chief engineer of the department, and L. A. Porter was the engineer directly in charge of the work. The contractor was Baton Construction Co. of Philadelphia, Pa.

COMPREHENSIVE MOTOR TRANSPORT SURVEY IN PENNSYLVANIA

Definitely to determine the nature and amount of future traffic that will use Pennsylvania roads, so the pavement may be designed adequately to carry the traffic, the Pennsylvania State Highway Department began a motor transport survey on allimp ortant roads on Nov. 8, 1923. In this survey it is being joined by the United States road department.

"The information gained through this survey will be used in determining the width and thickness of the pavements we will put down," said William H. Connell, Deputy Secretary of Highways and Engineering Executive of the Highway Department. "It is important that in build ing roads Pennsylvania have as accurate an idea as possible of the traffic which will use those roads. In railroad construction the corporations follow this idea. The telephone corporations and electric railway companies do likewise. There is nothing haphazard in their planning. They know what they are doing before

they do it. That should be—and will be, Pennsylvania's method in the construction of highways. Through it the State will be able to conserve its resources; and at the same time build highways which will carry the loads of the present and of the future—because our study of this problem is primarily an investigation of the probable future development of the country through which the various road sections pass."

This transport survey is the most intensive ever undertaken by any American state or foreign country. It involves the operation of 78-truck weighing stations and over 300 recording stations, distributed over Pennsylvania's primary and secondary highway systems in a manner calculated to give the most accurate estimate of the state's road traffic. The survey will continue for a whole year, it is believed. At the various weighing and otherstat ions there will be signs calling upon traffic to stop, so the traffic recorders can get the necessary information.

"So that our work may be expedited," said Mr. Connell, "we request the cooperation of all automobile operators—not only as to stopping when asked to do so, but as to furnishing information desired."

Motorists will be asked to fill in cards, so the following information may be secured: License number of motor vehicle, width and type of body, manufacturer, capacity (loaded and light); weight.

COMPETITIVE BIDDING BETWEEN ENGINEERS

To the Editor:—

Your editorial in the October issue of Municipal and County Engineering apparently invited further discussion of the question of selecting consulting engineers through what you are pleased to term a "competitive bidding contest" for the purpose of "hammering down the price." For the purpose of inaugurating such a discussion I submit the following thoughts:

1. That healthy competition among engineers is not only legitimate, but desirable, provided the competition is not on such a basis that the fee is cut down below that established by custom and at which the engineer can afford to give his client the best service there is in him and every bit of the attention needed for the successful and economical completion of the work for which his services were engaged.

2. We may find persons who will argue that if competitive bidding among contractors is proper and in the best interests of the owner, which, of course, seems to be the uniformly accepted idea and which, in the case of public works is usually required by law, then there is no reason why similar competition for the services of an engineer is not equally wholesome and advisable. Such persons probably do not stop to see the difference. In the case of contractors, every one is particularly anxious for a certain job and bids low, possibly too low, but he always has the chance by hard work, attention to details and shrewdness in many ways to reduce his costs of completing the work. Furthermore, in bidding, he follows specifications which show him exactly what he has to produce or deliver, and after that it is only a question of handling the work so that it will cost him a minimum amount.

It is different with the professional services of an engineer. In the best interests of his client, the necessity of attempting to cut the cost of his work in order to show a profit on a small fee should never be put up to him. He should be free to give whatever attention the work may from time to time require. While he is presumably under contract with his client to perform certain services, such as preparing plans and specifications, the making of a report or the supervision of construction, such contracts in the very nature of the case, are necessarily in general terms, which practically must leave it entirely to the engineer's conception of the service that any particular piece of work requires.

The engineer therefore should be assured that if he gives his client the kind of service the job demands, his fee will be such that he can afford to give it.

Very truly yours,

ARTHUR S. MILINOWSKI.

Of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn., Oct. 24, 1923.

A CRITICISM OF THE FORM AND FINANCING OF PUBLIC WORKS CONTRACTS

By W. W. Horner, Chief Engineer of Sewers and Paving, City Hall, St. Louis, Mo.

(Editor's Note: The following paragraphs are from Mr. Horner's presidential address at the recent annual meeting

of the American Society for Municipal Improvements.)

With all its detail studies of the specifications for materials and methods involved in public work, the American Society for Municipal Improvements in the past has given little consideration to the forms of contracts. Apparently only one of our committees, that on specifications for sewers, has had the courage to attempt to include a form of contract with its specifications. The hesitancy in this direction has undoubtedly been due to a feeling that the Society should keep away from matters legal and political. At the present time, however, I know of no phase of municipal work which is subject to so much criticism as is the form of contract in common use. These contracts are extremely unfortunate in at least two particulars; that is, in regard to the "lowest responsible bidder," and with respect to the "requirements for rigid adherence to plans and specifications" and the limitation on the discretion of the contracting officials.

Both of these conditions have undoubtedly grown out of serious abuses in the past, and there is no question but that there is still a very definite need for the municipalities to protect themselves against manipulation and collusion, to a greater extent than occurs in private work. There is still in the air a feeling that the city's money is anybody's money that can get it, and that 50 cents on the dollar is a fair return for the money put in public work. We all know that these are very common opinions in the mind of the average citizen, but we also appreciate that the better organization of the bigger cities, particularly in regard to their Engineering Bureaus, and the growing intelligence as to public affairs, even in small communities, are making these hazards of less importance than the necessity of carrying on the city's business in a business-like way.

I recently had the honor of representing this Society at a meeting of the Board of Directors of the Associated General Contractors of America. The matter of a standardization for contractors of public work was under discussion. I was much interested to learn of the work which had been done in the renovation of the federal contract, and particularly in the suggestion for defining in advance a responsible bidder, and for broadening somewhat the discretion of the engineering executives charged with the supervision of contract work. I took occasion at this time to suggest that following the adoption of the federal contract, the Associated General Contractors should appoint a special committee on municipal contracts, and should call on the American Society for Municipal Improvements to act with them in preparing a standard document. I have no doubt that this work will be undertaken and in anticipation of it feel that we should appoint next year a committee on contracts, which should begin the study of this subject and be prepared to confer when called upon.

Another phase of municipal work which is even more far reaching in its iniquity than some of the so-called unfair stipulations, is the method of payment quite commonly provided. I refer to those contracts which are financed from local assessments, and which constitute a very large part of the business of the cities. It is still the custom in most of the cities of the country to pay in the form of some special tax lien, whether this is called a special tax bill or a local improvement bond makes no particular difference. These bills or bonds are not based on the cities' general credit, but are secured only by a lien on the local property. In some instances they are marketed by the city and payments are made in cash, but in these instances there is sometimes a question as to the sufficiency of funds for the particular project. Where this old system has been retained in its entirety, as it has in St. Louis, there exists hazards to the contractor, and the expense involved in collecting these tax bills on completion, and where the experienced contractor in this line has made proper provisions for these difficulties, then there has been added to the cost of the work a very large item which finally falls on the local property holder. The cost of financing public work in this manner in some cities now amounts to as much as 30 per cent of the actual cost of construction, and is a direct loss to the whole community. The removal of this obsolete system can only be accomplished by public education and the direct influencing of legislation. At my suggestion, the Committee on Municipal Legislation and Finance of the American Society for Municipal Improvements has taken up the study of a standard code governing the financing of local improvements. As this is also a matter which I do not think can be satisfactorily worked out from any one viewpoint, I have during the past year requested the Board of Directors of the Investment Bankers' Association of America and of the Associated General Contractors of

America, to co-operate with us. It is proposed to organize a conference which will prepare a report of recommended practice for local improvement financing, and an accompanying draft of proposed statutes, which can be presented to cities and states for enactment. These Societies can act jointly in the matter of public education and propaganda toward the legislative bodies, to the end that all states may pass enabling legislation permitting the financing of local improvement work on an economical basis.

ARKANSAS DISTRICT SYSTEM OF ROAD BUILDING CALLED UNJUST

In a letter to P. R. Barnes, chairman of the Federal Relations Committee of the State Senate, Secretary of Agriculture Wallace recently condemned emphatically the road district system under which roads have been built in Arkansas in recent years, as an unjust and inequitable system which puts a grossly unfair burden upon farm land adjacent to the highways. At the same time he states that he is not authorized to prescribe the manner in which money shall be raised for road construction in the state. That, according to the Secretary, is for the people of the state to decide and the legislature to work out.

The Secretary's letter is addressed to the Chairman of the Senate Committee and serves as an answer to the scores of petitions he has received from citizens of the state and members of the Legislature, calling upon his to put a stop to the practice of financing road improvement by the special road district plan, which the petitioners claim has resulted in taxation of farm lands so burdensome as to be practically confiscatory. The responsibility for the continuance of the system is squarely upon the shoulders of the people of the state and their representatives in the Legislature.

The government has from the beginning maintained a hands-off policy in respect to the method of raising money in Arkansas, according to Secretary Wallace. He feels that the local district system is wrong in principle, and grossly unfair. He states that this view has been expressed repeatedly throughout the controversy over the situation in Arkansas, but he is not authorized under the law to require the abandonment of the system as a condition of the resumption of federal aid payments.

Under the Federal Highway Act each state submits to the Department of Agriculture a system of interstate and intercounty roads not exceeding 7 per cent of its total public road mileage. Over this system of roads, when constructed, the inter-state, state and inter-county traffic will flow. The system is designed to connect the large centers of population and county seats, thus covering the state with a network of highways for the use of city and town traffic, and for interstate traffic as well as for the benefit of the agricultural population adjacent to the highways. In the view of the Secretary, therefore, the assessments for money to be raised by the state ought to be distributed as widely as possible over all of the people of the state. If, as it appears, this view is widely held in Arkansas, the Secretary expressed the hope that the time may be ripe for the Legislature in the special session called by the Governor to work out a plan of financing the needed road construction and maintenance in a way that will be just to all the people.

PRACTICE IN STREET AND SIDEWALK DESIGN IN VARIOUS CITIES

(Editor's Note: The data given herewith are from the report of the Committee on Street and Sidewalk Design, as submitted at the recent annual convention of the American Society for Municipal Improvements. Mr. E. R. Conant, 168 Winthrop Road, Brookline, Mass., is chairman of the committee. Other members are Messrs. P. L. Brockway, S. Q. Cannon and H. E. Barnes.)

We all recognize the fact that the coordination of vehicles for transportation and the pavement, which carries it, is a deep problem for the engineer to continually work upon. The perfection of the automobile and truck has advanced ahead of pavement construction that will satisfactorily give service to the rapidly increasing volume of automobile and truck traffic.

During a comparatively short period highway officials, consulting engineers, laboratories and various societies and associations have been working upon improved street designs and methods of construction of pavement and eliminating, at least in part, the mistakes and weaknesses of the past. The importance of traffic analysis is being more and more

recognized and, when the amount and character of traffic for a proposed thoroughfare is ascertained, then the foundation is laid for the designing of the type that will meet requirements of traffic conditions and withstand the shocks and use to which it is to be subjected.

The Asphalt Association has collected information, perhaps the first of its nature, showing the amount of municipal paving that has been constructed in cities of the United States. The Association received reports from 209 cities, which included all but three with a population exceeding 10,000, and the tabulation of the replies shows that over 600,000,000 sq. yds. of pavement have been laid which exist today. If this paving was extended in one roadway, 18 ft. wide, it would have a length of nearly 57,000 miles. Of the total pavement reported, 78 per cent is of a type of construction higher than water-bound macadam. When subdivided, 54 per cent is of asphalt or bituminous type, 22 per cent brick, 12 per cent stone block, 3 per cent wood block, 5 per cent Portland cement, 2 per cent tar macadam, and 2 per cent miscellaneous.

Radii of Curb at Street and Lane Intersections

That municipal and other engineers are recognizing the advantage gained with long radius corners is shown by the replies received to our questionnaire sent to many cities, which indicate that a decided reaction has set in of late as regards adoption of the radii length.

Hartford, Conn., reports changing from 6 ft. to 12 ft. and 15 ft., and states a great improvement is noticeable with this change.

Waterloo, Iowa, originally had 10 ft.; a few years ago changed to 15 ft., is now adopting 30 ft., and this year changed some dozen street intersections to meet new requirements.

Toronto, Canada, had originally 12 ft., then changed to 18 ft. and now has adopted 25 ft.

Los Angeles reports that it uses a radius at curb corners equal to the width between the curb and property line, except where the distance on both streets is 15 ft. or greater. In such cases the radius is made 5 ft. greater than this distance.

Muskogee, Oklahoma. Here is a case where the narrower streets are given the greater radii; 24 to 30 ft. streets have radii at corners of 12 ft. to 15 ft., while for 30 ft. or over, a 10-ft. radius.

Pawtucket, Rhode Island, increasing radius from 15 to 25 ft. Davenport, 10 to 15 ft. Cheyenne, Wyoming, new pavements, 18 ft. Other cities report adopting radii of from 10 to 25 ft.

No information was received as regards the introduction of compound curves at corners.

Elimination of Catch Basins

The Committee received many replies concerning catch basin and inlet construction, and finds that there is a decided tendency toward eliminating catch basins, and connecting the inlets direct to sewers or storm water conduits, and especially is this done where there are adequate-sized storm sewers with good slopes.

The following cities report elimination, either complete or in progress: Quincy, Ill.; Muskogee, Okla.; Peoria, Kalamazoo, South Bend, St. Louis, Tulsa, Oklahoma City, Rockford, Shreveport, Long Beach, Houston, Cheyenne, Portland, Ore.; Oakland, Colorado Springs, Berkeley, Sacramento, Boise City and Salt Lake City.

An unusual method of disposing of storm water drainage is reported from Phoenix, Ariz. No storm water sewers have been constructed and, to care for storm water disposal, wells 6 ft. internal diameter are sunk to water-bearing sand, usually 20 and sometimes 30 ft. below the surface. Brick is used for construction, and within 6 ft. from the top it is of open construction and the bottom is left open. With proper inlets into the wells, it is asserted that satisfactory results are attained, the water-bearing sand taking away the discharge. The wells are expected to care for about 45,000 sq. ft. The diameter of inlet pipes to sewers are reported to range from 8 to 15 ins.

Storm Water Inlets

Information was sought as to size and type of inlets generally in use, and replies received would indicate that some standardization of construction would be desirable. Grade of streets and character of surface affecting run off, and amount of detritus carried, density of rainfall and minor local conditions all bear upon the best method to follow for carrying away surface water.

One answer received, while humorous yet speaks the truth. The engineer reports that he can not see much advantage in the use of grates in the curb openings. Years ago the openings in the gutters in this country were held down to small square openings, limited to the size of a calf's hoof. Of late years calves are moved by truck, and some of these old grates will have to go.

Many cities report openings through curb only, others openings in gutters and in curbs. Many use rods, horizontal or vertical, or gratings in the curb openings. Others adopt clear openings from 6 to 8 in. in depth and of varying length. Openings into inlets are sometimes sunk an inch or so below curb grade and pavement sloped back to grade.

St. Louis standard inlets are 4½ ft. width in front and taper to 3 ft. 9 ins. back, with depth of opening 6 ins. and multiples of these are usual to meet variable conditions.

Approaches to Garage Driveways and Parking Places

Present practice seems to be generally to adopt a uniform slope from gutter or from curb sunk to within about 2 in. of gutter grade, up to sidewalk through grass plot, if such exists; if not, a short ramp with steep slope of from 1 to 2 in. to the foot.

Two or three cities, Rockford, Muskogee, Jacksonville, Hartford, merge curb and gutter with rather long radius from the face and short radius for top of curb, and vehicles pass over the curb without serious trouble.

Chicago installs some catch basins adjoining raised crossings to care for drainage flow, and construct aporns running back from top of curb, with grade of ½ in. to the foot.

Richmond, Ind.; Pontiac, Mich., Oklahoma City; Boise, Idaho and Indianapolis report constructing a gutter a few feet out from the curb, and constructing crossing ramp from this gutter to curb.

Special Curb and Gutter Construction

An innovation as to the cross section of curb is being introduced, which appears practical and beneficial. We all know that automobile and truck tires are often injured by grinding against the vertical rough stone curb, and a few cities are adopting a curb with a batter on the gutter side, and again this batter is sometimes merged with the gutter and curb formed with a curved face.

Jacksonville, Fla.; Shreveport, La.; Salt Lake City; Phoenix, Ariz.; Sacramento and Hartford are introducing this method to a greater or less extent.

Quite a number of cities, where they have bituminous type of pavements, are introducing a gutter of from 4½ to 6 ft. wide, built of concrete brick or hard surface, which would not be affected by gasoline or oil drippings from automobiles or trucks. Boise, Idaho; Muskogee, Sacramento and St. Louis report this improvement.

Sidewalk Design

Some additional information was obtained as regards sidewalk widths generally adopted ,and means of relieving congested foot traffic.

San Francisco is constructing underpasses for pedestrian traffic at major boulevard intersections.

A few replies received report fixed widths of sidewalks for varying street widths.

Oakland, California, reports for

40 ft. street, 8 ft. sidewalk
50 ft. street, 10 ft. sidewalk
60 ft. street, 14 ft. sidewalk
80 ft. street, 18 ft. sidewalk
100 ft. street, 20 ft. sidewalk

San Francisco:

40-50 ft. street, 10 ft. sidewalk
50-60 ft. street, 13 ft. sidewalk
60-70 ft. street, 15 ft. sidewalk
70-80 ft. street, 18 ft. sidewalk
80-100 ft. street, 19 ft. sidewalk
100-or over st., 22 ft. sidewalk

Streets less than 40 ft., sidewalk width one-fifth of street width.

Brookline, Massachusetts, allots one-sixth of the width of the street in business sections, where widths do not exceed 60 ft., to sidewalk space.

From twenty answers to our inquiry as regards width of sidewalk, we note the average width for residential streets to be from 4½ to 6 ft., and for business thoroughfares a varying width from 14 to 25 ft. Shreveport reports that 40 per cent of street width has to be allotted to sidewalk.

Special Features of Design

Oak Park, Ill., reports removal of grass plots in the center of certain thoroughfares, for parking places.

St. Louis has adopted additional parking space by surrounding certain areas in wide streets with curbing 2 in. high, over which autos to park can readily pass.

Brookline, Mass., has taken away a portion of the space formerly allotted for a bridle path, and uses it for parking space.

Boise City allots a width of 16 ft. for parking, in the center of a 100-ft. boulevard. Salt Lake City uses a strip bordering the street railway tracks for parking cars. Rockford, Ill., is designing streets with parkway in center.

In some cities there are commons or small parks, with sidewalks outside of them. These sidewalks could be transferred inside the commons and space used for parking. But to do this, state legislation is usually required. It would appear that individual treatment has to be given for each case, and every effort must be made to relieve existing conditions in many cities for care of cars.

Pavement Construction

In the past year two features are outstanding, which will result in economy as regards street construction.

The Department of Commerce has recently announced that the new standard for asphalt grading (as determined by penetration limits) becomes effective Jan. 1, 1924. Hereafter, instead of 50 or 100 grades, the new standard will comprise 10. This follows earnest work done by the producers and consumers, and it now behooves asphalt users to see that their specifications adhere to the adopted grades, the ranges for which, as regards penetration limits, is sufficient to provide for all reasonable requirements.

New standards for establishing sizes of brick were also consummated the past year, and instead of 66 varieties in use before standardization took place, there are now but 6.

The penetration limits for asphalt used in asphaltic pavements is being decidedly reduced, according to information received from a large number of cities. Also quite a few reports using additional amount of dust. The changes bring about a harder mixture and one that prevents pushing and shoving under traffic.

St. Louis, Chicago, Wichita, Oak Park, report the penetration used from 30 to 40 for heavy traffic streets; from 40 to 50 for lighter traffic; and a number report using a lower penetration without stating limits.

St. Louis, in addition to lowering the penetration limit, has increased the amount of material retained on a No. 40 sieve. The mix used in refined asphalt wearing surface being:

Retained on No. 10 mesh sieve	8%
Retained on No. 40 mesh sieve	34%
Retained on No. 80 mesh sieve	25%
Retained on No. 200 mesh sieve	10%
Passing 200 mesh sieve	14%
Bitumen	9%

Experience with this mix is reported to give a close compact surface, which irons out well and does not push or become wavy under traffic.

Information received from many engineers show that they are increasing the concrete base thickness and, in some instances, increasing the thickness of the wearing surface.

Peoria, Wichita, Davenport, Oak Park, St. Louis, Tulsa, Sioux City, Pontiac, Oklahoma City and New Orleans, report increase of depth of base of about 1 in. The average adopted for heavy traffic being from 7 to 9 ins., medium, 6 to 7 ins.; light, 5 to 6 ins.

It would be interesting to learn from what basis or theory the increase in thickness has been worked out, but our questionnaire unfortunately did not call for this information and none was furnished.

Indianapolis reports that the concrete base laid in the city shall be roughened by an approved roughening device.

Muskogee, Oklahoma, requires a compression test of concrete pavements, within a given period. Samples are taken from the pavement and, if the required test is not met, removal of the rejected section is required. If it runs 80 per cent of the strength required, it may remain in place and be accepted, the city reserving, however 20 to 50 per cent of the contract price for the yardage in question until the end of the payment period. In addition, the city is protected by the maintenance bond.

Mr. Carpentar of Pawtucket reports a rather unusual method of making payment, under the cost-plus basis. The paving done amounts to about $300,000 per year and is contracted for and paid on the cost-plus basis. Before the contract is made, a fair estimate of the cost per square yard is agreed upon and the contractor is to be paid the actual cost, plus 15 per cent upon the estimated cost, if the final cost does not exceed this sum. If the final cost does exceed this sum, he is to pay all such excess cost, until his percentage of profit is reduced to 10 per cent, as figured upon the estimated cost per square yard.

Beyond this point of reduction, the city will pay the extra cost. Should the contractor succeed in laying this pavement for less than the estimated cost, he will receive 15 per cent upon such estimated cost and one-half of the saving he will have made to the city.

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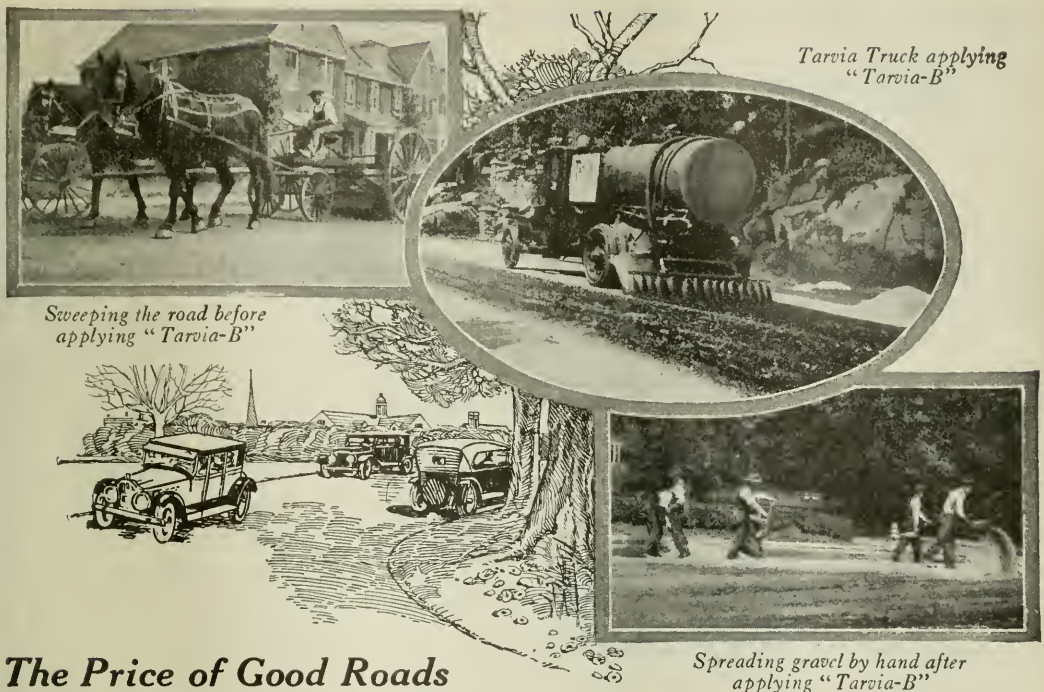
The smaller sewers of Chicago are smaller sewers of Chicago are, of course, built of vitrified salt glazed clay pipe, as in any other city. Those of larger diameter are of hard-burned brick. They are plain circular sections, one brick thick up to a diameter of 2½ ft., two brick thick up to 10 ft. and four brick thick over 10 ft.



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—Asphalt Tool Wagon
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—Bars, Reinforcing
—Bins, Portable Stone
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—Brick Rattlers
—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
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—Gravel Screener
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—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—Newell Constr. Co., Ave. A, Birmingham, contract by State Hwy. Dept for 20 miles graveling and small amt. of grading, at $196,923.

Ala., Selma—Alabama Concrete Products Co., Selma Ala., awarded contract for grading and paving 180,000 sq. yds., First and Waters Aves., at $285,000.

Ark., Mena—J. J. Harrison, Okla. City, Okla., awarded contract to build 11.2 miles Foran Gap, Forest Hwy. Ark National Forest, Polk and Scott Cos., at $75,000.

Ark., Russellville—Western Construction Co., Little Rock, Ark., awarded contract at approx. $125,000 for bldg. 15 miles road with rock base with asph. and gravel binder from Dover no. to the Ozark Forest Reserve.

Cal., Bakersfield—Griffith Co., 502 L. A. Ry. Bldg., Los Angeles, awarded contract by Co. Supvrs. for impvt. of certain roads in Rd. Impvt. Dist. 26—Patch to Arvin—9.129 miles, at $238,000.

Cal., Fresno—W. F. Hanrahan, Brix Bldg., Fresno, awarded contract by City Comn. at $59,800 for paving McKinley Ave., involving 182,530 sq. ft. grading at 5.8c sq. ft.; 144,798 sq. ft. asph. pavement; 12,958 sq. ft. gutter; 6,898 ft. curb; 15,132 sq. ft. walk; 405 ft. 12-in. type A culvert; 93 ft. 12-in. B culvt. 66 ft. 18-in. culvt.; 12 manholes; E. A. McAlpin, Fresno, awarded contr. for impvt. of Wishon, College, Van Ness Blvd. and Horoa Sts., Fresno, at $4,874.

Cal., Lynwood—Hall-Johnson Co., Box 51, Inglewood, awarded contract for 404,100 sq. ft. paving on Poplar Dr., macadam, at $107,-500; 227,075 sq. ft. S. Long Beach Blvd., 5-6 in. conc., at $64,000; 109,000 ft. Long Beach Blvd., 5-6 in. conc., at $30,900.

Cal., Redondo—Kuhn Bros. awarded contract at 65c per square yard for impvt. of Topaz, Knob Hill, Elvira Aves., etc., by repaving approx. 258,485 sq. yds. with rock, oil and screening pavement.

Que., Montreal—B. Brault, Ltd., 2855 Rosemount Blvd., awarded contract for paving Gouin Blvd., 38,535 sq. yds., 3-in. asphalt, at $243,486.

Fla., W. Palm Beach—Palm Beach County Commrs. let contract for 7 roads as follows: 3 mi. Stuart-Annie rd. thru Hanson, Grant and 5 mi. St. Lucie Ave. rd., Salerno to Stuart-Annie rd. to McVey Lindsay, at $30,-166; R. Tomasello, contracts for following: 2 mi. Tropical Farms rd., at $15,600; 4 mi. Kerns rd. at $4,900; 3 mi. Napp rd. at $8,000; M. F. Myers at $32,500 for 61,000 ft. Stuart-Annie rd., ferry to Lake Okeechobee; Mulford rd., steel drawbridge across so. fork of St. Lucie river, to Champion Bridge Co., Atlanta, Ga., at $38,000.

Kans., Anthony—Shultz & Shultz, Wichita, awarded contract for grading and sand-clay surfacing 9.521 mi. Proj. 155, Sec. A, and 9.987 mi. FAP 154, Sec. A, Harper Co., both 18 ft., at $93,715 and $69,139 respectively.

Ky., Frankfort—Following contracts let by State Hwy. Department: Daviess Co., 2.64 mi., grade and drain, to Costello Bros., Knoxville, Tenn., at $25,051; Henderson Co.,

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—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
—Liquid Chlorine
—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead-Lined
—Pipe, Steel
—Pipe, Wrought Iron
—Pipe, Wooden
—Pitometers
—Pumps, Air Lift
—Pumps, Boiler Feed
—Pumps, Centrifugal
—Pumps, Deep Well
—Pumps, Steam
—Pumps, Trench
—Pumps, Turbine
—Pumping Engines
—Service Boxes
—Soda Ash
—Specials, Cast Iron
—Standpipes
—Steam Boilers
—Steel, Reinforcing
—Sulphate of Alumina
—Tamping Machines
—Tanks, Elevated
—Tapping Machines
—Trench Braces
—Trenching Machines
—Valve Boxes
—Valve Inserters
—Valves, Gates
—Valves, Pressure Regulating
—Water Main Cleaners
—Water Meters
—Water Softening Plants
—Welding Apparatus
—Well Drills
—Well Screens
—Well Strainers

8.599 mi. gravel, to Corum Bros., Madisonville, Ky., at $155,948; Hopkins Co., Sec. G, 8.82 mi. gravel to Peacock Const. Co., Yaio, Mich., at $95,003; Hopkins Co., Sec. F, 10.368 mi. gravel to N. E. Stone & Co., Madisonville, Ky., at $136,604; Knox Co., 2.485 mi. grade and drain to Costello Bros. & Lusk, Knoxville, Tenn., at $65,857; McLean Co., 5 595 mi. gravel to Corum Bros., Madisonville, Ky., at $60,49; Nicholas Co., 7 mi. waterbound macadam to J. S. Walton & Co., Princeton, Ky., at $39,445; Webster Co., 19.16 mi. gravel to Peacock Const. Co., Yale, Mich., at $209,802; Campbell Co., 3.156 mi. conc. to Edw. Hine & Sons, Harrison, O., at $111,534; Campbell and Pendleton Cos., 10.112 mi. concrete to Cynthiana Const. Co., Cynthiana, Ky., at $393,648, also constr. of 6.319 mi. conc. in Kenton Co., at $197,576; Powell Co., 1.306 mi. grade and drain to Robt. L. Shimfessel, Clay City, Ky., at $4,216; Pulaski Co., 0.137 mi. waterbound macadam to Cash & Lynn, Stanford, Ky., at $8,180.

Ky., Jackson—Northfork Construction Co., Jackson, awarded contract by State Hwy. Dept., for 7.32 miles Jackson-Compton rd. from Wildhurst to Wolfe Co. line, at $204,818.

Ill., Springfield—Following contracts let by State Hwy. Dept.: Paving Sections—S. B. I. Rte. 2, F. A. P., Sec. 78, Winnebago Co., 3.66 miles, 18 ft. in width, to Geo. W. Welch, Beloit, Wis., at $69,428; Sec. 7, Proj. 55, Bureau Co., 3.17 mi., 18 ft. wide, to M. Hayes & Sons, Chicago, Ill., at $74,782; Sec. 17, I. Proj. 55, Bureau Co., 3.65 mi., 18 ft. wide, to same contractor at $89,886. Grading Sections —Louis Rich Constr. Co., E. St. Louis,, Ill., contracts as follows: Rte. 34, Secs. 1A, 2A, 3A, 4A and 5A, Saline, Pope-Hardin and Hardin Cos., 4.57, 5.78, 5.32, 5.60 and 6.54 miles, at $44,457, $33,458, $69,632, $45,750 and $127,878 respectively.

Ill., Winnetka—H. G. Goelitz, 810 North Blvd., Oak Park, Ill., awarded contract by Bd. of Local Impvts., for 12,000 sq. yds. rein. conc. pavement, at $119,000.

La., Crowley—McIntosh Co., Okla. City, awarded contract for installing fire alarm system and paving with rein. conc. or sheet asphalt Parkenson Avenue, at $196,845.

Md., Baltimore—Board of Awards let contracts for grading, curbing and paving streets in Contr. 245-OCOANA; 3,290 sq. yds. vit. brick, 14,760 c. y. grading, to D. Marine, Knickerbocker Bldg., $62,440; streets in Contr. 264-OANA, 22,170 sq. yds. asphalt, to Baltimore Asphalt Block and Tile Co., 1320 N. Monroe St., at $96,248.

Mass., Boston—State Hwy. Dept. let contracts for bitum. mac. paving on 21,046 ft. highway, 18 ft., in Truro and Wellfleet, to Lano Constr. Co., 37 Colony St., Meriden, Conn., at $110,086; 2,480 ft., 30 ft. wide in Scituate, to Reynolds Bros., Inc., 179 Summer St., Boston, at $28,068.

Mich., Lansing—State Trunk Line contracts let as follows: Rd. 25-2 A, Luce Co., Pentland Twp., Cl. B, 16 ft. wide, 5.977 mi., to Luce County Rd. Comm., Leland, Mich., at $82,991; Rd. 40-6, B, Van Buren Co., Paw Paw and Almena Twps., Cl. B, 16 ft. wide, 5.421 mi., to Wilder, Gould & Cross, Grand Rapids, Mich , at $60,579. Rd. 27-17, A-1, A-2, A-3, St. Clair Co., Clay and Cottrellville Twps., Cl. D. S., 1,874 mi., to Closser Bros., Detroit, at $3,873. Rd. 27-17-A-A, St. Clair Co., Cottrellville Twp., grading and shaping, 0.692 mi., to Closser Bros., Detroit, at $1,536. Rd. 27-17, A-1, St. Clair Co., Clay and Cottrellville Twps., grading and sheet piling, 0.311 miles, to Closser Bros., Detroit, at $4,959. Rd. 16-1, A-1 and C-1, Livingston Co., Green Oak and Brighton Twps., Cl. G and DS, 0.644, 0.227 miles, to State Construction Work, at $8,800. Rd. 16-23, Livingston Co., Geno and Brighton Twps., Cl. G and DS, 0.491 mi., to State Construction Work, at $4,950. Fed. Aid contracts let as follows: Rd. F. A. 89-D, Jackson Co., Parma Twp., Cl. F, 20 ft. wide, 5 696 mi., to Rockford Const. Co., Rockford, Ohio, at $124,395; Rd. F. A. 89-D, $49,290 est. cost of cement.

Mich., Lansing—Following Mich. Trunk Line contracts let: Rd. 14-10 A, Clare Co., Hayes Twp., Cl. B, 16 ft. wide, 1.669 mi., to Bruce, Stockwell & McAnnish, Harrison, Mich., at $13,959; Rd. 27-6 A and B, Huron Co., Sand Beach and Sherman Twps., Cl. B, 16 ft. wide, 9.329 mi., to Huron Co. Rd. Comm., Bad Axe, Mich., at $98,464; Rd. 13-32 B, Emmet Co., Harbor Springs, Cl. F. Base, 20 ft. wide, 0.563 mi., to W. B. Chalmers Co., Grand Rapids, Mich., at $9,186; Rd. 4606, Ingham Co., Stockbridge, culvt., to J. W. McKnight, Big Rapids, Mich., at $2,985; Rd. 13-32 B (est. cost of cement), $3,075; Rd. 55-10, Roscommon Co., Roscommon Twp., Cl. B, 16 ft. wide, 6.304 mi., to Du Vall Bros., McBain, Mich., at $58,771; Rd. 51-6, Ottawa Co., Holland Twp., Cl. F-rein., 20 ft. wide, 1.110 mi., to Ottawa Co. Rd. Comm., Grand Haven, Mich., at $28,527; Rd. 51-6 (est. cost of cement), $9,532.

Mich., Lansing—State Trunk Line contracts let as follows: Rd. 17-6, A-2 and B, Washtenaw Co., cities of Ann Arbor and Ypsilanti, Cl. sheet asphalt, 20 ft. wide, 1.108 mi., to Ann Arbor Asphalt Constr. Co., Ann Arbor, Mich., at $29,762; Rd. 49-12, Ingham Co., Vevay Twp., Cl. Culvert, to Ingham Co. Rd. Comm., Mason, Mich., at $1,904. Mich. Fed. Aid contract awarded to E. A. Campbell, Kalamazoo, at $144,780 for Rd. 66C, St. Jos. Co., White Pigeon and Sturgis Twps., Cl. F-Rein., 18 feet wide, 6.380 miles.

Minn., St. Paul—Contracts for paving, grading, graveling, brdgs., culverts, etc., let by State Hwy. Dept. as follows: State Proj. 5-34, FAP 92, 23.6 mi. Paving to Universal Engrg. Co., Eau Claire, Wis., at $307,871; graveling to Central Rd. Constr. Co., Minneapolis, at $25,770; State Proj. 3-34, FAP 303, 14.6 miles; grading to Winstone Bros., 801 Globe Bldg., Mnpls., and Geo. J. Grant Constr. Co., St. Paul, at $179,383; culverts to David Graham, Hibbing, at $24,852; State Proj. 1-39, Div. B, FAP 296, 7 mi.; grading to Cameron & Joyce, Keokuk, Ia., at $46,662; culverts to Guaranty Constr. Co., 301 Essex Bldg., Mnpls., at $4,623; brdg. 4007 to Campbell Constr. Co., 3050 Hennepin Ave., Mnpls., at $13,800. State Proj. 16-21, FAP 314, 17.2 mi.; grading (A) to Spencer & Chambers, Marshall, at $61,886; grading (B) to Stevens Bros., St. Paul, at $68,004; culverts to Noble Peterson, Windom, at $7,148; bridge 3796 to Independent Bridge Co., 1101 Met. Life Bldg., Mnpls., at $11,000; brdg. 3795 to Guaranty Construction Co., 301 Essex Bldg., Mnpls., at $16,460; bridge 3797 to Iowa Bridge Co., 317 McKnight Bldg., Mnpls., at $11,888. State Proj. 16-22, FAP 315, 7 mi.; grading to Lobnitz Grading Co., Olivia, at $24,990; culvert to Chas. N. Hanson, Atwater, at $4,711. State Proj. 32-24, FAP 323, 7 miles; grading to be awarded later; culverts to the Pritchard Co., Thf. River Falls, at $1,486.

Miss., New Albany—Nixon & Phillips, Lineville, Ala., awarded contract by Union Co. Supvrs. Dists. Nos. 1, 2 and 3, at $155,-132, 20-mile road.

Nev., Carson City—C. Miles, Sacramento, awarded contract by State Dept. of Hwys. for grading and constructing culverts in Washoe Co. on Proj. 73, at $74,693; Fred Coolidge, Laramie, Wyo., contract by State Dept. for constr. of Proj. 56, grading, constructing culverts and placing gravel surf. in Churchill Co., bet. Eastgate and East County line, at $173,147.

N. J., Asbury Park—J. J. Barrett, No. Olden Ave., Trenton, awarded contract for bitum- conc. paving of 27,000 sq. yds. Kingsley St. and 17,500 sq. yds. Coolman Ave., at $102,339.

N. Y., Brooklyn—Following contracts let by E. Riegelmann, Boro. President: Sicilian Asphalt Pav. Co., 41 Park Row, New York, contract for repaving N. 7th St., at $33,793, Saratoga Ave., $13,714, both asph.; Uvalde Asphalt Paving Co., 1 Bway, New York, 12th Ave., $22,364; Douglass St., $7,462; Suydam St., $5,997; regrading and paving Kingston Ave., $18,696, all asphalt; Cranford Co., 52 Ninth St., repaving 79th St., $20,020; 80th St., $8,407; paving 46th St., $5,681; 77th St.,

$18,977; 77th St., $9,602; 83rd St., $8,971, all asphalt: Brooklyn Alcatraz Asphalt Co., 407 Hamilton Ave., repaving 99th St., $7,333; paving E. 14th St., $8,161; E. 19th St., $10,916; W. 27th St., $9,882, all asphalt; Greico Bros., 12 Russell St., repaving N. 7th St., St., granite blk., at $32,897; J. D. Norton, 20 Sterling Pl., Union St., granite blk., $70,885; W. J. McHale Contg. Co., 1250 Jefferson St., grading, curbing and flagging 40th St., $5,520; F. Persioano, 350 Fulton St., 80th and 81st Sts., $902; G. M. Mandatto, 129 29th St., E. 19th St., $3,435.

N. Y., Brooklyn—N. J. O'Hara, 1228 Park Ave., New York, awarded contract by Park Board, Municipal Bldg., for grading, sheet asph. paving, etc., main roadway of Eastern Parkway, from Albany to Ralph Aves., here, at $147,081.

N. Y., Long Isl. City—Sicilian Asphalt Paving Co., 41 Park Row, New York City, awarded contract for grading, curbing, laying sidewalk, etc., on 101st (Jerome) Ave., at $110,020.

N. Y., New York—Fleming Shepard, Inc., 116 Broad St., awarded contract by Pres. Manhattan Boro. for grading, regrading, curbing, flagging and reflagging W. 165th St., at $11,046; repaving Riverside Dr., stone-filled sheet asph., to Asphalt Construction Co., 208 Broadway, at $137,657.

N. C., Salisbury—Ely Constr. Co., Augusta, Ga., awarded contract for sheet asphalt paving—40,000 sq. yds. various streets —at $166,000.

Oklahoma, Guymon—Jas. Stanton Constr. Co., Leavenworth, Kans., award. contract at $70,000 to pave 5 blocks on Main St., and at $20,000 for impvts. around Rock Island R. R. station.

Okla., Okla. City—State Hwy. Dept. let contracts as follows for 3 roads: Creek Co., Proj. 88, 1.63 mi. hard surface road, to General Construction Co., Okla. City, at $54,168; Pawnee Co., Proj. 85, 11.57 mi. gravel rd., to McCoy & Son, at $144,973: Ottawa Co., 3.64 mi. reconstructed old rock base rd., with chats and Topeka top, to General Construction Co., Okla. City, at $85,315.

Okla., Okla. City—City let contracts at $82,376 for paving about 10 blocks as follows: Western Paving Co., at $24,979, for Ave. B; at $19,946 for 45th St.; $9,998.35 for 44th St.; Reinhart & Donovan, to pave alley in Blk. 39, and at $10,452 for Ave. B, Klein to Douglas; M. A. Swatek Co., for 11th St., to Blks. 15 and 16, Summers Addn., and at $9,119 for 11th St.; all Okla. City.

R. I., Providence—State Bd. Pub. Works let contracts as follows: Bitum. macadam pavement 3.04 miles Pontiac Rd., 18 ft., in Cranston and Warwick, to Lane Constr. Corp., 37 Colony St., Meriden, Conn., at $89,024; 3.09 mi. Cumberland-Wrentham Rd., 18 ft., in Woonsocket, to B. Perini & Sons, Ashland, Mass., at $102,053.

Tex., Angleton—P. G. Burns, Angleton, Texas, awarded contract Brazoria Co. Rd. Dist. No. 16, at $350,000, for 1st section of crushed rock, shell and asphalt road north from Anchor, at $350,000.

Tex., Center—Bramer & Wilder, Houston, Tex., awarded contract by City and Shelby Co. for paving as follows: City, $40,131.62; County, $122,847.

Tex., Coleman—Buchanan & Veasey, Temple, awarded contract for gravel surfacing rd. bet. Rockwood and Colorado River; grade and construct draing. structs, on Coleman-Glen Cove rd. to E. Blankenstein, Temple, Tex.; 8 steel trusses with conc. flrs. and conc. substruct. to Austin Bridge Co., Dallas; total, $80,000.

Tex., Dallas—Fuller Constr. Co., Slaughter Bldg., awarded contract for paving with Willite asph. conc. 2-in. top on 6-in. conc., 137,058 sq. yds. on various streets, at $455,697.

Tex., Hemphill—Sabine County let following contracts for roads: Concrete drainage structs. and laying iron ore gravel on 7.10 mi. State Hwy. 21, Milam to Pendleton, to E. M. Wood, Royse City, Tex., at $120,006; construct conc. culverts and timber brdg. and lay 8-in. gravel on 8.38 mi. State Hwy. No. 8, Brookeland to Pineland, to George & Kerr, Lufkin, Texas, at $131,000.

Tex., Kountze—Brimmer & Wilder, Houston, awarded contract by Hardin County for 2 roads; grade, construct bridges, culverts and gravel 14 miles State Hwy. No. 40, Kountze to Village Hills, at $60,000; grade and improve 12 miles State Hwy. No. 8, Silsbee to Evadale, at $115,000.

Wash., Olympia—Following contracts let by State Hwy. Comn.: 1—Clearg., gradg. and draing. abt. 4.09 mi. Anatono-Asotin hwy. from Asotin south in Asotin Co., at $48,149; 2—Clearg., gradg., draing. and surfacg. with gravel about 2.93 miles perm. hwy. No. 9, from Anacortes east in Skagit Co., at $29,514; 3—Clearg., gradg., draing. and surfacing with crushed gravel abt. 5.81 miles of N. Central hwy. betw. Jared and Blueside, in Pend Oreille Co., at $83,375; 4—Gradg., draing. and surfacing with crushed rock about 12.2 miles of N. Central hwy. from Odessa west in Lincoln Co., FAP 129, at $99,294; 5—Grading, draining and surfacing with crush. gravel abt. 11.7 mi. Inland Empire Hwy., bet. Wallula and Burbank, Walla Walla Co., at $5,157.

Wash., Seattle—Romano & Co. awarded contract for sewers in 32nd Ave. south et al. (clay pipe) at $39,139; Goetz & Brennan, contract for grading, paving, etc., Avalon Way et al., at $320,508 (clay pipe), also awarded contract for sewers in Brandon St. et al., at $81,588 (clay pipe); C. L. Creelan, contract for paving 59th Ave. S. W., at $6,200; also contract for paving, filling, etc., W. Connecticut St., at $8,374.

SEWERAGE AND SEWAGE TREATMENT

Ark., Hot Springs—Ed B. Mooney, local, awarded contract for laying 10,400 ft. sewer at $41,000.

Cal., Alhambra—Hickey & Harmon, 58 2nd St., San Francisco, awarded contract for constr. of sewer system in Dists. 3 and 5, at $62,386 for Dist. 3 and $74,384 for Dist. 5. Work involves 52,956 lin. ft. 8-in. vit. sewer, 137 manholes, 46 flush tanks, 1,491 hse. connections of 4-in. cast iron pipe.

Ont., Ft. Erie—F. F. Fry Co., Ltd., 43 Scott St., Toronto, awarded contract for conc. and vit. clay sewers at $43,270.

Cal., Long Beach—P. S. Tomich, 425 N. Fremont, Los Angeles, awarded contract for constr. of sewer system in Anaheim, Daisy, Loma Vista and other streets at $78,000.

Cal., Pasadena—S. M. Milovich, 858 S. Figueroa St., Los Angeles, awarded contract for constr. of sewer system on Allen Ave., Mountain St. to city limits, at $1,899; Adam Dalmatin and Mike Guho awarded contract for constr. of Linda Vista sewer sys., at $67,000; Dan Oakovitch awarded contract for sewer system in Palm Terrace and Claremont Dr., at $4,800.

Ont., Fort Erie—F. F. Fry, Ltd., 43 Scott St., Toronto, award. contract for sewerage system at $50,000.

Ont., Sandwich—Webster Constr. Co., Bank of Toronto Bldg., London, awarded contract for Partington Ave. sewer, at $30,000.

Iowa, Des Moines—G. G. Herrick, 607 Observatory Bldg., awarded contract for Southwest Sewerage System; 43,806 lin. ft. 10-24 in. pipe sewer; 28,100 lin. ft. 27-48 in- circsewer; 1 dry weather outfall complete, 1 inverted siphon, etc., complete, at $626,909.

Kans., Cherryvale—Ammerman & Snyder, Wichita, awarded contract for sewage disp. plant and outfall sewer at $51,366.

Md., Baltimore—Ryan Constr. Co., Real Est. Bldg., Philadelphia, awarded contract for constr. of storm water drains and sansewers in Bellwood Ave., near Belair Rd. Storm water constr. 64,900 ft. 6-9 ft. rein. conc. drain and 700 ft. 18-ft. in. san. sewer, etc., at $33,482.

Md., Baltimore—D. C. McAleer, Phoenix Bldg., awarded contract by Board of Awards for sewers in Storm Water Contr. 61 and in San. Contr. 206, at $49,928 and $59,724 respectively.

Mich., Springwells—T. D. Nolan, 22 Highland Ave., Highland Park (Detroit P. O.), contract for 7,290 ft. 12-27 in. vit. crock sewer in Special Assessment Dist. 23, at $14,-900; S. Healy, 400 Penobscot Bldg., Detroit, 2,464 ft. 36-72 in. conc. sewer in Sec. 39, Ford Rd. sewer, $34,889; 2,470 ft. 36-66 in-conc. sewer in Sec. 40, Donald Ave., at $34,-889.

Minn., Winona—Wm. Fraser & Son, 810 Guardian Life Bldg., St. Paul, awarded contract in conjunction with Pastoret Constr. Co., 308 Sellwood Bldg., Duluth, for laying sewers, at $93,301.

Mo., Marceline—Ray & Son, Baxter Springs, Kansas, awarded contract for main sewers and sewage disposal plant, at $50,247.

Mo., Ridgeway—Ole Johnson, Alden, Ia., awarded contract for construction of sewer system at $90,000.

Mo., St. Joseph—Hanson & Willadson, Omaha, Neb., awarded contract for construction of lower Whitehead sewer, at $114,-675.

Mo., St. Joseph—Owings & Shofner, Atchison, Kans., awarded contr. for 3,136 ft. rein. conc. double box and 2,186 ft. 9x9 ft. conc. box sewer for Browns Branch, at $211,226.

Mo., Unionville—Gjellefald-Chapman Co., Forest City, Ia., awarded contract for san. sewers at $71,835.

N. Y., Long Isl. City—D. Nonnacci awarded contract for san. sewer in Owens St., etc., at $81,487.

N. Y., Syracuse—Roberts Filter Co., Darby, Pa., awarded contract for equipment and machinery for disposal plant, at $76,000.

O., Cleveland—Winterbottom & Connelly, 1815 Corning Ave., award. contract for segmental blk. sewers in Ridge Rd. (Secs. 1-7), at $193,056.

Ohio, Columbus—Following contracts let for sewers: Franklin Co., 12,608 ft. 8-18 in. vit. sewer and 3,000 ft. 8-in. cast iron mains in Sewer Dist. Marion 2 (No. Whittier Garden area), Contr. 16, to W. D. Winchell, 338 Seibert St., at $41,783; 3,556 ft. cast iron mains in Sewer Dist. Franklin 3, Contr. 29, and 2,644 ft. 8-in. vit. sewers in Sewer Dist. 3, Contr. 28, to W. Neilson, 160 Lane Ave., at $5,626 each.

Ohio, Euclid—Contracts for sewers and water mains in 4 streets to J. B. Lyon, Euclid, at $8,448; 3 streets to Massouff & Co., 3184 W. 25th St., Cleveland, at $5,527; 5 streets to A. C. Hattendorf, Stop 14, Euclid Ave., Cleveland, $48,992; 5 streets to Curro & Whitaker, 2269 Noble Rd., Cleveland, at $46,505.

Ohio, Euclid—F. B. Stein, Euclid, awarded contract for disp. plant for Lake Shore Blvd., at $190,616.

O., E. Liverpool—P. Milliron, 2nd St., awarded contract for 1¾ miles san. sewer in Sewer Dist. 2, East End, at $90,000.

O., Zanesville—Adams Bros. Cotg. Co., Muskingum Ave., awarded contract for lateral sewers for Southwest sewerage system, at $305,150.

Pa., Wilkes Barre—B. G. Coon Constr. Co., Wilkes Barre, awarded contract for brick storm sewers in Bowman, Skidder and Scott Sts., at $49,282.

Tex., Clarksville—Mitchell Constr. Co., Houston, awarded contract to construct sewage disposal plant and sewer lines. Cost about $30,000.

Tex., Laredo—Kirkwood & Wharton, San Antonio, Tex., awarded contract at approx. $63,000 for constr. of storm sewer. Pre-cast rein. concrete pipe will be used for the main sewers.

Tex., Stamford—McAman Constr. Co., Stamford, awarded contract for ½-m. g. plant and Imhoff tanks, at $31,500.

Va., Richmond City—Smith Bros. awarded contract for constr. of sewers on various streets at $81,433; for materials, Warner, Moore & Co., at $59,073.

Wash., Seattle—Romano & Co. awarded contract for sewers in 32nd Ave., et al., at $39,139 (clay pipe); also contract for sewers in Brandon St., et al., at $81,588 (clay pipe).

WATER SUPPLY AND PURIFICATION

Cal., Los Angeles—Pacific Pipe & Supply Co., 1002 Santa Fe Ave., awarded contract by Public Service Comn. for furnishing French made cast iron pipe f. o. b. Aqua siding, in 4-metre lengths, at $325,788.

Colo., Denver—R. L. Hanes, 617 E. 1st Ave., awarded contract for impvts. to Ashland Ave. reservoir, east and west basins, at $85,477. Extra wk.: Item 1, excav. and grading, $1.60 per c. y.; Item 2, removing condemned soil and replacing with new soil, $2.50 cu. yd.; Item 3, conc. and form work, $18 per c. y. Large c. i. pipe (altern. prop. accepted) to U. S. Cast Iron Pipe & Fdry. Co., Tarrant City, Birmingham, Ala., at $175,067; small pipe to Colorado Fuel & Iron Co., 6-24 in. pipe, $60, total $74,627; vert. valves to Rensselaer Valve Co., 50 Church St., N. Y. City, 25 4-in. hub end, 250 6-in., 30 8-in., 15 10-in., 75 12-in. two 24-in., 10 24-in., 15 36-in., 4 48-in., 3 48-in. flange; total, $69,895.

Idaho, Lewiston—Chanut Constr. Co., Chanute, Kans., awarded contract for water works impvts., including filtr. plant, 2 reservoirs, 6 miles cast iron pipe, etc., at $346,600.

Ind., South Bend—Board Public Works let contracts for water works station as follows: Bldg. and founds., to Hay-Wever Co., So. Bend, at $157,400; suct. well to Phelps & Son, Knoxville, at $27,000; chimney to H. R. Heinicke, Inc., 540 N. Meridian St., Indianapolis, at $6,083; pumps to Allis-Chalmers Co., 1410 Waldheim Bldg., Kansas City, Mo., at $69,900; boilers to Union Iron Wks., Lackawanna Siding, Hoboken, N. J., at $23,008; coal and ash handling equipt., to Link-Belt Co., 910 S. Mich. Ave., Chicago, at $12,143.

Ky., Pond Creek—J. E. Nelson & Sons, 3240 S. Michigan Ave., Chicago, awarded contract by Ill. Central R. R. Co., 135 E. 11th Pl., Chicago, for pumping station, elev. steel tank, etc., here. Cost to exceed $40,000.

Ky., Powderly—J. E. Nelson & Son, 3240 S. Michigan Ave., Chicago, awarded contract by Ill. Central R. R. Co., Chicago, for water treating plant and pumping station; est. cost, $40,000.

Kans., Kansas City—Arkansas Bridge Co., 1503 Waldheim Bldg., Kansas City, Mo., awarded contract for rein. conc. reservoir, 259x433 ft., 24 ft. high, at $274,600.

Kans., Winfield—Central Fdry Co., 332 S. Michigan St., Chicago, Ill., awarded contract for water works extensions, including 22,000 ft. 16-in. pipe, at $87,560.

Mass., Stoneham—(Boston P. O.) Worthington Pump and Mchy. Corp., 115 Broadway, New York City, awarded contract by Met. Dist. Comn. for crank and flywheel cross-compound pump, 20-m. g. d., at $69,-000.

Miss., Moorhead—G. P. Sledge, Abbeville, La., awarded contract to construct water works plant at cost $50,000. Wk. includes 100,000 gal. tank lines, 8-in., 6-in. and 4-in. pipe; two 500-g. p. m. pumps, etc. Henry A. Mentz, Cons. Engrs., Magnolia, Miss.

Mo., Canton—James & Anderson, Woodriver, Ill., awarded contr. for water works and sewers at $74,000.

Mo., Ridgeway—C. C. Johnson, Iowa Falls, Iowa, awarded contract for water works, at $40,420.

N. Y., Albany—E. B. Stevenson, Albany, awarded contract for repairing retaining wall of basins, removing and replacing new sand, etc., in filtration plant, at $62,277.

N. Y., Long Isl. City—J. A. Gregory, 351 E. 124th St., New York City, awarded contract for water mains in Anable, Woolsey and 6th Aves., etc., at $42,572.

N. C., Andrews—Mayor let following contracts for constr. work on proposed municipally-owned hydro-electric power plant on Hiawassee River: Tucker & Laxton, Inc., Charlotte, N. C., awarded contract for construction of power house, dam, substation and transmission line from plant to Andrews; all electrical equipt. to General Electric Co., Schenectady, N. Y.; S. Morgan

Smith, York, Pa., contract for all hydraulic equipt. and accessories.

Okla., Sulphur—W. B. Scott, Sulphur, awarded contract for motor driven pump units, conc. reservoir, tower, 4,400 ft. 6 and 8-inch cast iron pipe, etc., at cost plus 10 per cent, not to exceed $43,500.

Okla., Tulsa—E. J. Merkle, Kansas City, Mo., awarded contract to construct Mohawk pumping station (Spavinaw water project), at $220,000; Jno. V. Bolan, St. Louis, Mo., at $5,000 for conc. chimney. Will probably let contract to H. L. Cannaday, Tulsa, for pipe line system.

O., Cleveland—Stange-Walsh Constr. Co., 2315 Fairmount Rd., contract for filter and administration bldgs., and 7 gatehouse superstructs. for Baldwin filtration plant, Contr. 47, at $2,885,300; Schrader Construction Co., Euclid-46th St. Market Bldg., award. contract for 1-sty. 30x40 ft. conc. gate houses at Fairmount reservoir, at $63,-313.

Ore., Beaverton—American Woodpipe Co., Tacoma, Wash., awarded contract for new city water system here, at $42,911. Six miles 8-in. main are to be laid from Council Crest, near Portland, to connect with reservoir to be built 1 mile east of city.

Wash, Yakima—Coluccio & Erickson, Yakima, awarded contract for conc. pipe line to be installed on 7th St., at $50,676.

Prospective Work

ROADS AND STREETS

Ala., Mobile—City contemplates expendt. of $302,960 for paving certain streets here. Wright Smith, City Engineer.

Ark., Arkadelphia—State Hwy. Dept., Little Rock, Arkansas, plans to improve Arkadelphia-Hot Springs rd.; also 5 miles Bankhead Hwy., from Arkadelphia to Caddo river brdg.

Ark., Little Rock—State Hwy. Dept., Little Rock, contemplates expending about $3,-300,000 for impvt. of highways in Pulaski County.

Cal., Nat'l Forest Rd.—Dist. Engr., Bureau of Public Roads, U. S. Dept. of Agriculture, No. 9 Main St., San Francisco, plans to advertise Yuba Pass National Forest Hwy. Proj. early in January, for constr. during season of 1924. Location survey made of project and center line staked. Blue prints showing center line and tentative grades ready for distribution to interested contractors. Design and contract quantities not yet completed. C. H. Sweetser, Engr.

Cal., Sacramento—Practically all of the Calif. sec. of Pacific Hwy. bet. Redding and Ore. state line, excepting those stretches now paved, will be rebuilt within next 2 yrs. Commission prepared to spend $1,500,000 or more in abolishing curves, widening rd. to width of from 24 to 30 ft., and cutting down grades on the 50-mi. rd. so. from Dunsmuir to Redding. There is a total of 140 mi. thru mountainous sects. of Shasta and Siskiyou Cos., of which 52 miles are paved.

Fla., Barton—Polk County plans to construct 106 mi. 15-ft. asphalt road and widen 9-ft. rd. to 15 ft. Will vote on $3,360,000 bonds. For detailed information address Co. Commrs.

Fla., Brooksville—Hernando County Commrs. plan to construct 70 miles of rock and asphalt roads. Contemplate voting on $450,-000 bonds.

Fla., Frostproof—City considering 9 miles of street paving, extending of water mains, erecting city hall, etc.; $300,000 bonds voted.

Ga., Atlanta—Peters St. Impvt. Assn. (Geo. W. West, Pres.) interested in widening Peters St., S. Forsyth to Park St., west end. City will furnish $140,000. C. E. Kauffman, Engr. in Dept. of Constr.

Ga., Thomasville—City plans to expend $100,000 for additional street paving.

Idaho, Boise—Contracts for $1,000,000 road work will be let by State Hwy. Comn. before January 1, 1924. Contract for paved hwy. in Shoshone Co., bet. Kellogg and Mullan, 17 miles, to cost abt .$700,000, will be let this year and work will start as soon as possible in 1924. Within a month contract for hwy. work bet. Priest river and Laclede, 7 miles, will be let, involving expenditure of $175,000. Wm. J. Hall, Commr.

Ill., Wyoming—Town is preparing to pave about 12 blocks in business section; work will start in spring. Jos. L. Duran, Supt. Stark County, Toulon, Ill.

Ia., Jefferson—Greene County will complete paving of Lincoln Hwy. across county in 1924; 1,800 carloads of material, 4,600 tons material per mile of work done; 87,400 tons for project. Est. cost, $28,000 per mile, or $518,000 for project; $453,250 Fed. aid; Co. to pay $64,750. G. A. Coburn, Co. Aud.

Iowa, Manchester—City contemplates paving 60 blocks during 1924. Engineer not selected. F. B. Blair, Mayor.

La., Bastrop—Morehouse Parish plans letting contract in abt. 6 weeks for bldg. 150 miles highway.

La., Baton Rouge—City considering paving about 100 streets. W. P. Burden, Secy. of Comn. Council.

La., Lafayette—$300,000 bonds voted for bldg. road bet. Clarenero and St. Landry Parish line in Lafayette Parish; also to pave Johnson Ave., in Lafayette, as well as 9 other roads in parish.

La., Lake Charles—City plans expdt. of about $2,000,000 for street and sidewalk paving.

La., New Orleans—City plans expending $1,000,000 for paving various streets here. For detailed information address the Mayor.

Minn., Alexandria—Douglas County voted in favor of $250,000 bond issue for road work on Hwy. 29, known as the Alexandria-Parkers Prairie Rd., near here. Vernon Thomas, Aud.

Miss., Biloxi—$90,000 voted here for street impvts. and beach protection. Jno. J. Kennedy, Mayor.

Mo., Moberly—City Council has retained Benham Engineering Co., Kansas City, Mo., as Cons. Engrs. on paving improvebents. It is planned to put thru large program of resurfacing in 1924. Plans will be worked out immediately so that prelim. details may be completed in time for actual constr. work to start in Spring. Rolla Rothwell, Mayor.

Mo., Warrenton—State Hwy. Dept. at Jefferson plans to construct 4 concrete roads in Warren County from St. Louis to Kansas City, as follows: 3.579 mi. Fed. and State Proj. 236-A, Rte 2; 4.523 mi. State and Fed. Proj. 236-C, Rte. 2; 4.374 mi. State and Fed. Proi. 236-B. Rte. 2; 4.834 mi. State and Fed. Proj. 236-D, Rte. 2. B. N. Piepmeier, Chf. Engineer.

Mont., Livingston—Petitions being circulated for paving, curbing and constructing storm sewers in residential streets. Est. cost, $200,000. Harry H. Shelver, City Clk.

Neb., Omaha—Ords. passed for Impvt. Dists. 2437, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462 2463 and 2464. Pave and curb with apsh. stone, vit. brick, vit. blk., artificial stone, macad., creo. wood blk., or asph. concrete. C. F. Bossie, City Clk.

S. C., Laurens—Laurens County plans highway and bridge impvts.; contemplates $1,000,000 bond issue. J. E. Jacobs, Vice-Chmn. of County Comn.

S. Car., Sumter—Sumter Co. will improve highways; $1,500,000 bonds voted for the improvement.

S. D., Pierre—Contracts will be let early in spring for grading and draining: F. A. F. 167, Bon Homme Co., Tyndall to Springfield, 9.8 miles, est. cost $31,663; F. A. P. 158, Clay--Turner Cos., Centerville to Vermillion, 23.5 miles, est. $108,262; F. A. 149, Spink Co., Redfield no., 25.5 miles, est. $83,-044. State Hwy. Comn., Pierre.

Tex., Anderson—$450,000 bonds voted for

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

road bldg. in Grimes Co., Rd. Dist. No. 1. R. M. West, Co. Judge.

Tex., Angleton—$350,000 bonds voted by Brazoria County for bldg. 11½ miles paved highway on Glacier-to-Gulf Rte., connecting with hard surfaced rds. in Harris Co. leading to Houston, Galveston and other ports; also joining this city with Angleton and Bay City; 4 miles of concrete and remainder of stone and shell base topped with bitum. material; lateral roads to be of conc. and bitum. material will lead to Damon and to Brazoria Co. line on each side.

Tex., Austin—Travis County will receive bids in about 30 days to grade and construct drainage structs. on St. Hwy. No. 2, Round Rock Rd., F. A. P. 409. Est. cost, $28,000. C. Leonard, Co. Engr. Geo. S. Mathews, Co Judge.

Tex, Carthage—Panola County contemplates bldg. highways east and west, north and south, through county. $225,000 bonds voted. A. D. Nelson, Co. Judge.

Tex., Dallas—City plans to expend $250,000 to $300,000 for paving 17 additional streets; Warrenite bitulithic, rock asph., Willite sheet apsh., Willite asph., conc. and vit. brick; 6-in. conc. base. Will soon receive bids. E. A. Kingsley, City Engr.

Tex., El Paso—$1,260,000 bonds voted here for road bldg. (69 miles) in El Paso County. L. A. White, Co. Engr. E. B. McClintock, Co. Judge.

Tex., Hallettsville—Lavaca County considering impvt. of 14.23 mi. State Hwy No. 2, F. A. P. 373-B. Est. cost, $165,053; Fed. aid $25,000. Secy. of Agriculture, U. S. Bureau of Public Rds., Washington, D. C., approved plans. W. B. Koether, Co. Engr., and C. L. Stairnoha, Co. Judge, Hallettsville, Tex.

Tex., Hemphill—Sabine County contemplates bldg. 5.85 mi. 16-ft. gravel road on State Hwy. No. 8, Tebo-Brooklyn Sec. Est. cost, $91,240; Fed. aid 50 per cent. W. A. French, Co. Engr., San Augustine; W. M. Davidson, County Judge, Hemphill.

Tex., Hillsboro—Hill County plans to construct 5.65 miles State Hwy., No. 2-A, Itasca Dist., gravel and bitum. top. Est. cost, $98,000. U. S. Dist. Engr., Fort Worth, approved plans. Guy W. Johnson, Engr. in charge; W. L. Wray, Co. Judge, Hillsboro, Tex.

Tex., Jacksboro—Jack County plans to construct bitum. macadam pavement on State Hwys. Nos. 25 and 26, and F. A. P. Hwy. which crosses county; $400,000 bonds voted; State and Fed. aid granted, $650,000. J. D. McComb, Co. Judge.

Tex., Jasper—Chf. Engr. U. S. Bureau of Public Roads, Washington, D. C., has approved plans for 6.06 mi. State Hwy. No. 7, bet. Jasper and Newton Co. line, Jasper Co., Fed. Aid Proj. 317-A. Est. cost, $129,146; Fed. aid, $46,620. C. P. Hunter, Co. Engr.; A. L. Hancock, Co. Judge.

Tex., Fairfield—Freestone County contemplates improving roads. Will vote Dec. 22 on $1,000,000 bonds.

Tex., Linden—Cass County plans road bldg.; may vote on $1,000,000 bonds. S. L. Henderson, Co. Judge.

Tex., Madisonville—$300,000 bonds voted in Madisonville County for road work. Road Dist. created composed of Precincts Nos. 1, 2 and 4. Plans road and highway impvts. T. Ferguson, Co. Judge.

Tex., Palestine—Anderson Co. will soon let contract to grade and construct drainage structs. on 9.7 miles 16 and 18-ft. conc. pavement on State Hwy. 19, F. A. P. 403. Est. cost $360,000. E. W. Davis, Co. Engr.; W. C Quick, Co. Judge.

Tex., Palo Pinto—Palo Pinto County will receive bids in about 60 days for 5 miles 18-ft. waterbound macadam, bitum. top road on State Hwy. No. 25, from Mineral Wells north. Approx. cost, $100,000. G. W. Courter, Co. Engr., Mineral Wells.

Tex., Sonora—Sutton County contemplates improving 37 miles Old Spanish Trail Hwy., Sonora to Kimble Co. line; grade, construct draing. structs. and gravel surface 17 miles; grade, construct draing. structs., 20.1 miles. Est. cost, $430,000. N. P. Stockton, Jr., Co. Engineer.

Wash, Olympia—Washington State Hwy. Comn. plans to construct 53 miles paving and 280 miles new rd. constr. in 1924, in addition to constr. of several brdgs. Est. cost of impvts., $5,300,000. 50 miles grading of Olympia hwy. planned. Large volume of wk. will be carried out in Eastern Wash. Gig Harbor branch of Navy Yd. Hwy. will be regraded and improved; 16-mile stretch of Lympia hwy., bet. McCleary and Elma, will be hard surfaced. Many other large projects are planned.

Wash, Olympia—Specfs. being completed for clearing entire 50 miles of right-of-way to close gap in Olympia Hwy., on west side of Olympic peninsula. It is hoped contracts can be let in January. Specfs. will be rushed to Washington, D. C., for approval of U. S. Bureau of Roads relative to use of Fed. aid and forest money. Job will be divided into 2 contracts. One will cover 22 mi., from Lunch creek on south to Kalock creek, abt. 10 mi. no. of Queets river; the other will cover northern section from Bogachiel river down to Kalock creek. State Hwy. Engr. Allen hopes and expects to have entire way cleared by next legislative session in January, 1925, when appropriations will be sought for grading and grubbing.

Wis., Elkhorn—(Walworth County) Co. Board has appropriated $5,000 for purch. of road machinery, and $433,332 voted for road construction. N. J. Peters, Comnr. Wausau (Marathon County) Co. Bd. voted $144,062 for rd. constr., $14,000 for purchase of rd. machy., including 1 12-ft. grader, patrol graders and gravel crusher, also screening plant. H. J. Vogt, Commr. Washburn (Bayfield County) Co. Bd. voted $58,470 for rd. construction and $10,000 for rd. machinery. Jno. Friberg, Commr. Medford (Taylor County) Co. Bd. voted road constr. program for 1924 amounting to $83,051 and $9,000 for rd. machinery. C. Klenhofer, Commr. Montello (Marquette Co.) Co. Bd. approp. $7,500 for purch. of rd. machinery, including crusher and truck; also $35,500 for road work. Herman Schmitz, Commr.

SEWERAGE AND SEWAGE TREATMENT

Ala., Fairfield—Exchange Club of Fairfield (J. W. Brooks, Chrmn) interested in constr. of county sewer iin Possum Valley. Est. cost, $1,000,000.

Cal., Gilroy—Plans prepared for sewage disposal plant. Est. cost, $100,000. C. E. Sloane, Santa Fe Bldg., San Francisco, Engr.

Cal., Morgan Hill—Plans prepared for sewerage sys., disposal plant, treatment plant, including Imhoff tanks, with separate sludge beds, sprinkling filter, etc. C. C. Kennedy, Call Bldg., San Francisco, Engr.

Cal., Pasadena—Board of Directors adopted resolution preparatory to calling election to vote $125,000 bonds to finance pipe line connections to sewage disposal plant.

Ont., Milton—City Council contemplates constr. of sewage disp. system. By-law will be submitted next January, and if passed work will start next year. Engineer-in-Charge, W. L. McFaul.

Ont., London—City Council contemplates sewer extensions at cost of $200,000. W. A. Near, Engr.-in-Charge.

Ga., Atlanta—City considering issuing $10,000,000 bonds for sewer construction during 1924. Wm. A. Hansell, Chf. of Construction.

Ga., Bainbridge—City plans to expend $100,000 for sewerage extensions. Work may begin first of year. O. H. Long, Engr., Moultrie, Ga.; A. B. Conger, Mayor.

Ga., Columbus—City (Walter Richards, Mgr) contemplates installing municipal sewer system to cost approx. $1,000,000, and to be laid within next 5 yrs.

Ill., Deerfield—Plans being prepared by Consoer Engineering Co., 140 S. Dearborn St., Chicago, for sewerage system and disposal plant. Est. cost, $150,000.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Canneiton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Canneiton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Ill., **Stickney**—Town contemplates constructing sewerage system at cost of $200,000. Consoer Engineering Co., 140 S. Dearborn St., Chicago, Cons. Engrs.

Ky., **Louisville**—Commrs. of Sewerage plan to construct central relief sewer, Broadway to Main and 9th Sts.; semi-elliptical, 9-ft. diam. Est. cost, $500,000. J. B. F. Breed, 417 W. Main St., Engr.

Mich., **Grand Rapids**—$5,000,000 bonds voted for disposal plant, storm water relief and intercepting sewers. M. P. Adams, City San. Engr.

Mo., **Carthage**—City has voted $110,000 bonds for extension of sewer and bldg. sewage disposal plant. C. F. Drake, Mayor.

N. J., **Riverton**—Revised plans being prepared for 11,500 lin. ft. 6-15 in. vit. clay sewers, Imhoff tanks, disp. plant, pumping station, etc.; $85,000. Sherman & Sleeper, Camden, Engrs.

N. Y., **Albany**—City contemplates extending 2 miles Patroons Creek sewer and branches from below Russell Rd. reservoir to Central Ave. Est. cost, $125,000. F. Ravens, City Hall, Engr.

N. Y., **Binghamton**—City plans to construct trunk sewer and improvements Trout Brook. Est. cost, $100,000. E. H. Prentice, City Engr. City also considering constr. of general impvts. and reclamation work in Brandywine swamp at cost of $500,000.

N. C., **Greensboro**—City (B. Y. Ward, Clk.) authorized issuance of $50,000 bonds for extending and enlarging sewer system. $50,000 for extending and enlarging water works; $500,000 for constr. and repair of streets and $50,000 for erecting and equipping city abattoir.

Ohio, **Massillon**—$300,000 bonds voted for trunk sewers here.

Okla., **Stroud**—$53,000 bonds voted for constr. of main sewers and sewage disposal plant. Benham Engineering Co., Cons. Engrs., Kans. City, Mo.

Pa., **Philadelphia**—$9,000,000 bonds voted here for sewage disposal plants and $3,300,000 for constr. of sewers.

Tenn., **Union City**—$125,000 bonds voted here for constr. of sewerage system and elec. light plant.

WATER SUPPLY AND PURIFICATION

Ala., **Birmingham**—Birmingham Water Works Co., (H. K. Horner, Gen. Supt.) plans expendt. of $420,000 next year for impr'ts: $20,000 for bldg. and completing superstruct. for 8 conc filters at Shade Mtn. plant; $45,000 for completion of piping, strainers and other betterments of the filters; 10 blocks of additional 12-in. main for Hillman Ave.; laying of 5,000 ft. 12-in. water main in E. Thomas; completion of 16-in. water main in Possum Valley Rd.; 12-in. reinforcing main on 16th St.; construction of 12-in. reinforcing main on 16th St. Company has also completed arrangements to take over Roebuck Water system.

Ont., **Toronto**—12 miles of 6-12 in. cast iron mains will probably be laid in Area A at $88,000 and in Area B at $170,000, York Twp. F. B. Goldike, 40 Jarvis St., Toronto, Engr.

Idaho, **Lewiston**—Plans announced by City Water Supt., E. G. Wagner, for installation of new filtration system at cost of $350,000, to handle 6 million gals. of water daily.

Kans., **Kansas City**—City plans to extend water plant; $275,000 for 25 m.g. settling basin, $160,000 for 12 miles new mains, $95,000 for 3 new pumping units. F. F. Beauchamp, Constr. Engr. Bonds voted.

Md., **Baltimore**—City has tentative program of proposed expendts. from $10,000,000 water loan; expending 4 million for impounding works; $250,000 for constructing new and impvts. to existing service stations; $350,000 for constructing new and enlarging present reservoirs; $400,000 for purchase of plants of remaining private water companies; $5,000,000 for distribution mains (supply, feeders and distributors). Howard N. Jackson, Pres. Board of Awards; A. Bernard Siems, Water Engr.

Mo., **Kansas City**—City will expend $11,000,000 for additional water supply (amt. provided under recent bond issue). 1st portion of new works to be let are in Contr. 1: A 7 ft. 6-in. conc. tunnel in rock, Contr. No. 2, branch tunnels, $25,000; A 7 ft. conc. tunnel in rock; probably 16 m.g. conc. covered reservoir later. Const. of Missouri Valley tunnel $15,000. Bids will be opened about Jan. 1, 1924, for pressure tunnels; will also install purification works, pumping stations and discharge mains. Will open machinery bids probably next spring. Fuller & Waitland, Engrs., 600 Walnut St., Kansas City.

Mo., **St. Louis**—Will probably take bids in February on three 66-in. cast iron pipe lines from new water plant at Howard's Bend to western city limits, about 14 miles. Altern. plan calls for two 72-in. lines. ($2,500,000. E. E. Wall, City Hall, Commr.

Mont., **Missoula**—City contemplates installation of new water supply system. Est. cost $900,000. Cons. Engrs., Burns & McDonell, 404 Marsh-Strong Bldg., Los Angeles, Cal.

Neb., **Kearney**—Contemplate following: Junking present plant; relocating new plant bet. 6th and 7th Ave.; concrete reservoir, 1,000,000 gals. capy.; three 24-in. wells with Diesel engines, each with 1,000 gals. capy. per min.; 29 additional hydrants. Est. cost about $140,000. Storm sewer west of Central Ave., starting on 31st St. to no. channel of Platte River. Burns-McConnell Engrg. Co., Kans. City, Mo., Cons. Engrs. V. B. Wheelock, City Clk.

Neb., **Lincoln**—Engineers have reported on possible sources of new water supply: Proj. 1—Springs at Sprague. Total est. cost $1,364,650. Proj. 2—Artesian wells at Beaver Crossing abt. 33 miles w. of Lincoln. Total est. cost $2,805,720. Proj. 3—Blue river abt. 20 mi. west of Lincoln. Total est. $215,400. Proj. 4—Platte River no. of Cedar Bluffs. Total est. $4,406,500. Proj. 5—Wells at Wahoo. Total est. $2,564,000. Proj. 6—Platte river at Ashland. Total est. $2,174,400. Projects 1, 3 and 6 considered best. Burns & McDonnell, Engrg. Co., Kansas City, Mo., Cons. Engrs. Theo. H. Berg, City Clk.

N. C., **Hickory**—City has authorized installation of gravity water system. Est. cost $90,000. Probable extension to nearby towns at total cost of about $2,250,000.

Ohio, **Crooksville**—Village contemplates constructing complete water system at cost of $400,000.

S. C., **Westminster**—$200,000 bonds voted for water and sewers. F. W. Cannon, Mayor.

Tex., **Dallas**—City (S. R. Alredge, Mayor) having survey made by J. C. Nagle and R. A. Thompson, Hydraulic Engrs., for developing water supply reservoir.

Tenn., **Knoxville**—W. J. Savage, T. H. Johnson, C. P. Ferris, Comm., appointed to make complete survey of water situation and make recommendations for new plant. City Mgr. has engaged The J. N. Chester Engineers, Pittsburgh, Pa., to make complete leak survey of City with view of stopping all leaks; repairs include new pump and motor for hydrate of lime mixer, also a 14-in. main from reservoir to standpipe, making available an additional 2,500,000 gals. of high pressure water daily. Will also make repairs to Worthington pump.

Vt., **Morrisville**—Village plans hydro-electric development, including concrete dam, power house, etc. Est. cost $150,000. C. A. Slayton, Morrisville, Engr. and Mgr.

Va., **Norfolk**—City Council of No. Norfolk, is considering appropriating $450,000 for developing municipal water system from Lake Drummond. May vote on bonds.

W. Va., **Keyser**—Council will receive bids in December or January for filtration plant in connection with water works system. $175,000 bond issue arranged for project.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Special Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Surface Heaters
Chausse Oil Burner Co.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Tool Heaters, Asphalt
Chausse Oil Burner Co.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

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